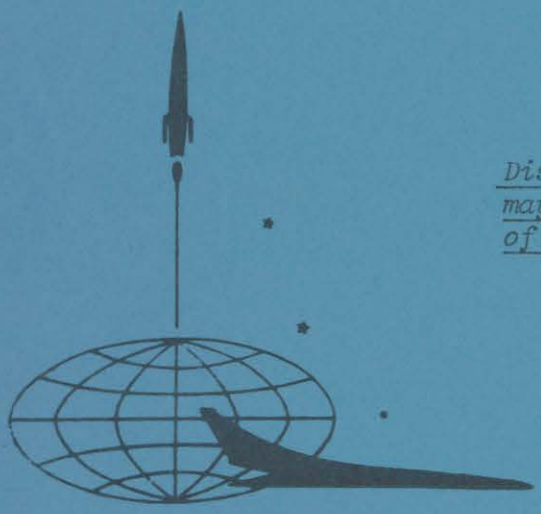
ATD Report 67-7 February 1968
Surveys of Foreign Scientific and Technical Literature

SOVIET NAVAL MEDICINE AND UNDERWATER PHYSIOLOGY



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ATD Work Assignment No. *N-67-2*

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FOREWORD

The purpose of this report was to search and abstract articles pertinent to or related to problems of naval medicine and underwater physiology in the Soviet-Bloc open source literature. Since it is the first report in this series, an effort was made to locate heretofore unexploited literature dating back to 1958. The report is broken down into eight main sections (see Table of Contents, p. v) and each section is provided with its own list of title headings (pp. 1, 9, 19, 49, 67, 76, 106, and 114). An author index has also been provided (p. 122). Unsigned articles were not included in this index.

The reader is reminded that additional Soviet-Bloc literature which may be pertinent to this work assignment has been and will continue to be reported on a current basis via the ATD Press, Foreign Science Bulletin, and ATD life sciences reports on Soviet bioastronautics and biotechnology. "Soviet Biotechnology and Bioastronautics", Report No. 4, will soon be published as a compilation of abstracts. Material directly pertinent to this work assignment will continue to be reported on a current basis for the contractor's use only.

Since the writing of this report, additional directly pertinent Soviet-Bloc monographs have been located. References are given below:

1. Beranek, K. and Macoun, K. Diving as a Sport (Sporitovni potapeni), Prague, 1963, 236 p. illus., biblio. (Czech., popular style)

2. Azhazha, V. G. Aquanauts (Gidronavty), Moscow, Izd-vo "Znaniye", 1964. 93 p. illus. (Russian, popular style).

3. Budanov, V. I. Methods of Expeditionary Investigations of Seashore Regions (Metodika ekspeditsionnykh issledovaniy beregovoy zony morya), Moscow, Izd-vo "Nauka", 1964, 223 p. illus., biblio. (Russian. Contains a section on diving and underwater photography)

4. Deringen, K. K. Man Conquers the Ocean Depths (Chelovek pokoryayet glubiny okeana), Moscow, Izd-vo "Nauka", 1965, 197 p. illus. (Russian, popular style)

5. Surovkin, V. D. and A. S. Ivanov (Eds.). The Preparation and Training of Divers (Podgotovka i trenirovka plovtsov-podvodnikov), Moscow, Izd-vo DOSAAF, 1966, 143 p. (Russian)

These materials will be processed pending a request from the contractor. [CD]

TABLE OF CONTENTS

Section I. Applied Submarine and Maritime Medicine

1. Metabolism of Submarine Personnel During a Cruise

SOURCE: Afanas'yev, B. G. and A. I. Ryuretskiy. Voyenno-meditsinskiy zhurnal, no. 7, 1964, 63-64.

The metabolism of submarine wheelmen and engine room personnel was studied during a cruise. Some results of the study (using a Douglas mask and Holden counter) are shown in the following tables.

Table 1. Day Shift

1.	2.	3.	4.	5.	6.	7.
8.	9,8	362,1	255,0	0,7	4,678	1,694
"	10,4	424,6	312,2	0,73	4,714	2,002
"	8,5	368,6	316,8	0,86	4,875	1,797
9.	15,8	439,3	439,3	1,0	5,047	2,217
"	9,7	454,0	288,4	0,63	4,594	2,086
"	7,6	237,8	220,3	0,92	4,948	1,177
"	11,7	443,0	344,0	0,78	4,776	2,116
"	14,8	477,9	427,2	0,89	4,912	2,347

1. Specialty, 2. expired air (liters), 3. O_2 consumption (cm^3/min), 4. CO_2 expired (cm^3/min), 5. respiratory coefficient, 6. caloric production of 1 liter O_2 at this respiratory coefficient value, 7. energy consumption kcal/min, 8. wheelman, 9. engine room.

Table 2. Night Shift

1.	2.	3.	4.	5.	6.	7.
8.	7,67	256,0	216,1	0,84	4,850	1,242
"	8,83	278,2	258,9	0,93	4,960	1,379
"	8,50	319,0	308,8	0,97	5,010	1,598
9.	7,33	309,1	245,1	0,79	4,789	1,480
"	7,50	318,0	286,0	0,90	4,924	1,566
"	9,17	288,3	269,1	0,93	4,960	1,428
"	9,00	355,8	307,0	0,86	4,875	1,735

1. Specialty, 2. expired air (liters, 3. O_2 consumption (cm^3/min), 4. CO_2 expired (cm^3/min), 5. respiratory coefficient, 6. caloric production of 1 liter O_2 at this respiratory coefficient value, 7. energy consumption kcal/min, 8. wheelman, 9. engine room.

This investigation showed that under favorable microclimate conditions, the energy requirements of the personnel examined were not substantially increased. [CD]

2. Notes on a Cruise of Soviet Atomic Submarines

SOURCE: Gromov, I. Six weeks in underwater orbit. Soviet military review, no. 7, 1966, 11-13 (summary)

This popular account reviews a six week voyage of a detachment of Soviet atomic submarines (the number or names of the submarines are not given) commanded by recently promoted Vice-Admiral A. Sorokin.

No details of living conditions aboard the submarines are presented. Some pastimes of crew members were said to include childrens games such as pin-table soccer, ice hockey, basketball etc. Practice alerts, the sounding of action stations, and other exercises kept the crew alert, prevented monotony, and "toned up tired muscles".

During the voyage, an American submarine was detected by instruments and passed. A "new instrument" developed by Soviet scientists (not described) is said to assure reliable communications between submarines and thus their coordination when submerged. The cruising speed of the submerged atomic submarine was only referred to as being close to that of an express train. No other life support or technical details were given. [CD]

3. Repair Operations Outside the Pressure Hull of a Submarine

SOURCE: Radushkevich, R. B. (Captain). Morskoy sbornik, no. 9, 1965, 71-75.

Considerations involved in making repairs outside the pressure hull of a submarine during a long cruise are discussed. Safety of the repair personnel is a major concern. The personnel should be carefully selected for their skill, discipline, and ability to handle themselves on wet decking. The repair party should be thoroughly briefed on the specific requirements of the repair operation, and simple but reliable communications should be established. The repair equipment, assembled before leaving home port, should include flashlights, protective clothing, safety line and harnesses, long hoses for the pneumatic tools, long cables for the welding units, etc. A team should be assembled in the compartment adjacent to the damaged section so as to render assistance and maintain communications. The executive officer usually exercises technical control, and the captain, stationed on the bridge, maintains contact with all groups and navigates the submarine so as to minimize the water washing over the deck. Speed must be held to a minimum while maintaining steerage way, and operations at water temperatures lower than +10C must be limited to two hours per man, followed by a medical check.

4. Evaluation of Conditions in Compartments of a Sunken Submarine by a Physician-physiologist

SOURCE: Myasnikov, A. P. (Docent) (Lieutenant Colonel of medical service); Fedotov, V. V. (Candidate of medical sciences) (Lieutenant Colonel of medical service). Morskoy sbornik, no. 9, 1965, 60-61.

The authors propose a graphic presentation of rescue operations in a sunken submarine, stating that existing tables are not sufficiently descriptive and are incomplete in their evaluation of an emergency situation (see Fig. 1 of the Enclosure). Such a graphic sys-

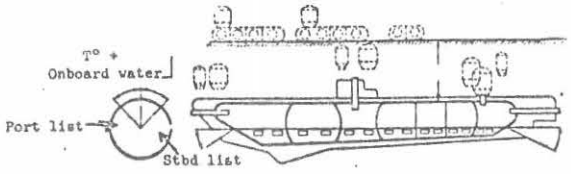


Fig. 1. System for evaluating conditions in compartments of a sunken submarine and the organization of personnel rescue

No. of escape hatches								
No. of regeneration devices								
No. of regenerative agent complexes								
4. Air supply in ventilation system								
5. Water supply								
6. Rations supply								
7. Condition of personnel								
8. Maximum subsistence time in compartments	9. Without regeneration							
	10. With utilization of regeneration agents	11. According to a temperature factor						
		12. According to the toxic effect of O_2						
		13. According to the toxic effect of CO_2						
		14. According to regeneration agent supply						

tem could be put on a form 50 x 100 cm. The authors go on to propose hypothetical situations which could occur in a sunken submarine, for the benefit of a physician-physiologist involved in rescue operations. The benefit of a graphic approach to submarine rescue operations is that it aids in developing clearcut habit patterns in officers and saves decision-making time. The authors' approach has been incorporated into the training practice in the Soviet Navy and at the Military Medical Academy imeni Kirov. [CD]

5. Soviet Atomic Submarine Rescue Capability

SOURCE: V. Latov. The Rocket Flies to the Target (Raketa letit k tseli). Izd. DOSAAF, Moscow. 1966. 41-46.

In a short, generalized section treating various aspects of the development of atomic submarines the author devotes most of his discussion to the sinking of the American atomic submarine, Thresher. Some mention is made of Soviet atomic submarines though no concrete details are presented. The reader is reminded of the 1963 polar cruise of the "Leninskiy Komsomol" under the command of Captain, 2 class D. Sysoyev. Though polar cruises are complicated, the are now a common phenomenon. Fleet Admiral S. G. Gorshkov is quoted as saying that soviet atomic submarines regularly cruise in both Arctic and equatorial waters.

In discussing rescue capabilities for sunken submarines, it is stated that the Soviet Navy is equipped with bathyscaphes, diving bells, and various diving suits for such purposes. Various diving and submarine rescue operations are described in general terms. It was stated that there are special training courses for submarine rescue divers. [CD]

6. II International Symposium on Maritime Medicine Gdansk-Gdynia (Poland), 16-19 September, 1965

SOURCE: Buczowski, Z. Bulletin of the Institute of Marine Medicine in Gdansk, Vol. XVII, no. 1/2, 1966. 91-92.

The Second International Symposium on Maritime Medicine was organized by the Institute of Marine Medicine in Gdansk. The scientific program of the Symposium was based on problems concerning factors injurious to health on merchant and fishing vessels. It included three general themes:

1. Hygiene Conception in Ship Construction, Sanitary Equipment, Water Supply and Sewage Removal from Ships (3 topic and 15 contributed papers);

2. Dependence of the Seaman's Health on the Working Conditions and Employment Duration on Sea, Including Problems of Mental Hygiene (1 topic and 26 contributed papers);

3. Nutrition of Crews, and Provisions on Vessels and Life Rafts (1 topic and 5 contributed papers).

All papers and reports presented at the Symposium will be published in the next issue of this Bulletin (1966, vol. 17, No. 3). [CD]

7. The Fourteenth Course in Maritime Medicine

SOURCE: Banaszkiewicz, T. Bulletin of the Institute of Marine Medicine in Gdansk, Vol. XVII, no. 1/2, 1966. 100

The Fourteenth Course in Maritime Medicine took place at the Institute of Marine Medicine in Gdansk from October 4 to October 30, 1965. This course was organized by the Institute for ship's surgeons, port medical officers, and physicians employed at shipyards and in fisheries.

The lecturers were members of the scientific staff of the Institute of Marine Medicine and specialists invited from other scientific institutions.

The course consisted of: lectures —112 hours, demonstrations and laboratory training —44 hours.

The program of the course included the following problems:

--hygiene in various climatic zones,
--hygiene on board ship,
--sanitary-epidemiology, prophylaxis and clinic of selected infectious and parasitic diseases the physicians could meet with in foreign as well as in home ports,
--skin and venereal diseases,
--medical entomology,
--traumatic surgery.

The lectures were richly illustrated with tables, plates and films.

The training took place in individual laboratories of the Institute, as well as in the field, and included demonstrations and practical work concerning occupational hygiene, sanitary problems, medical parasitology and entomology.

The final examination was passed by 27 physicians. [CD]

8. The Fifteenth Course in Maritime Medicine

SOURCE: Boj, E. Bulletin of the Institute of Marine Medicine in Gdansk, Vol. XVII, no. 1/2, 1966. 101-102.

The XV Course in Maritime Medicine, organized by the Institute of Marine Medicine, took place from November 2 to November 27, 1965, in Szczecin.

This course was intended for physicians specializing or working in maritime medicine, and for candidates applying for employment as ship's surgeons in the Polish Merchant Marine or in companies of deep sea fisheries.

58 physicians and 2 stomatologists participated in this course.

Contrary to the previous courses the participants of the course in Szczecin attended the lectures and the theoretical as well as practical training in the afternoon, after a shortened time of their occupation.

The course consisted of: lectures —46 hours, seminars —54 hours, practical training —40 hours.

The program included the following problems:
--hygiene on ships, etiology, epidemiology, prophylaxis,
--clinic of selected infectious and parasitic diseases,
--skin, tropical and occupational diseases,
--medical entomology,
--other diseases connected with work on sea and ships.

The lectures were read in the State Maritime School, the training took place at the Department of Biology and Parasitology of the Medical Academy, and at the Department of Hygiene of the Sanitary-Epidemiological Station in Szczecin.

The lecturers were: members of the scientific staff of the Institute of Marine Medicine (for the most part), of the Medical Academy and of the San.-Epid. Station as well as other specialists in marine medicine.

The course was terminated by an examination. [CD]

Section II. The Training of Submarine Crews and Divers

1. The Joint Training of Submarine Physicians and Medical Corpsmen

SOURCE: Kozulin, Ye. A. Voyenno-meditsinskiy zhurnal, no. 6, 1964, 54-56 (summary).

The autonomous nature of submarine operations necessitates joint, specialized training of submarine physicians and their medical corpsmen for emergency situations. In the case outlined by the author, a Major in the Medical Service, joint training takes place as an extension of regular training.

During the first week, the physicians are trained individually to become familiar with their working areas and various clerical procedures. Under the direction of an intern, the physician is given five to seven patients with various profiles to care for and is tested at the end of this period.

During the second week, the physician is examined on the clinical aspects, diagnosis, and treatment of acute appendicitis and strangulated hernia. The examination consists of discussions with a clinical supervisor and another submarine physician. At this time, two weeks are spent assisting a qualified surgeon during actual operations. At the end of this period, he is given an examination on the treatment of burns and wounds after studying the appropriate literature. Here, the physician actively participates in a polyclinic administering to flesh wounds, burns, ambulatory operations, abcesses, panorychias etc.

The supervisor of the medical corpsman is a qualified submarine physician. He composes a month-long program, taking into consideration the general level of development, degree of preparedness, and speciality of the corpsman.

During the first week, corpsman training takes place in a first-aid operating unit, where he becomes familiar with the instruments used on a submarine, participates in the preparation of first-aid material, sterilizes instruments, learns how to arrange instruments and suturing material correctly on a sterile table, and participates in the preparation and disposition of bandages.

The second week is spent completing this instruction program. During the third week, the corpsman directly participates in an operating room of a polyclinic assisting

his designated submarine physician in ambulatory operations. Under the supervision of a senior nurse, he washes prior to operations and learns the correct handling and dispatch of instruments. Finally, the corpsman learns how to prepare for an appendectomy.

During the fourth week under the supervision of his physician, the corpsman studies problems and procedures not sufficiently covered earlier. Here, the physician concentrates most heavily on such procedures as the preparation and sterilization of surgical instruments and materials used during an appendectomy, temporary curtailment of circulation, artificial respiration, and extremity immobilization due to fractures.

This joint training program terminates with two operations. The first operation and patient is chosen by the supervising intern. After this operation, errors and their avoidance are reviewed. The second operation is an appendectomy, as this condition is encountered more frequently under submarine conditions than other medical problems. A nurse assists the submarine physician and corpsman in this operation to verify the quality of their performance.

COMMENT: This article made no reference to other authors concerned with submarine medical training nor was there any bibliography. [CD]

2. Training Submarine Physicians and Sanitation Personnel

SOURCE: Zhuravlev, Yu. N. Voyenno-meditsinskiy zhurnal, no. 11, 1966, 55-56 (Summary)

This short article discusses in very general terms the disadvantages of training submarine physicians and medical corpsmen in shore installations as compared to training them on so-called floating bases. These floating bases, probably hospital ships, are far better equipped to duplicate conditions which would be encountered on a submarine. Physicians and their corpsmen are trained to conduct emergency operations under storm conditions. Some general instrument and operating room sterilization procedures are outlined. The author, a Captain in the Medical Service, concluded that the use of floating bases for training purposes constituted one additional

mode for better developing the combat readiness of submarine medical teams.

COMMENT: As is often true of the Military Medical Journal, no concrete bibliographic citations were given at the end of this article although the author mentioned a number of authors concerned with submarine medical training in the text. These included: N. P. Shostya and G. P. Ovechkin, 1963; Ye. A. Kozulin, 1964; V. V. Kholod, 1964; M. G. Ryff, 1963; I. Yu. Ozolin and Z. M. Eveshteyn, 1964. Instrument sterilization techniques during storm conditions were briefly discussed and the following authors (no year given) were cited: D. A. Streshinskiy, Yu. N. Zhuravlev, V. V. Lemus, and V. N. Vasil'yev. [CD]

3. Shipboard First-Aid Classes for Naval Personnel

SOURCE: Z. M. Evenshteyn, Candidate of medical sciences, Lieutenant Colonel in the Medical Service, Classes in Medical Preparation of Naval Personnel. Morskoy Sbornik, no. 1, 1966.

Visual aids have proved very useful in conducting shipboard first-aid briefings for naval personnel. Well-organized displays of drawings, photographs, etc. with text are used to demonstrate treatment of hemorrhages and fractures, with emergency materials commonly available on ships. A special display on prevention and treatment of disorders associated with diving is often included. First aid to naval personnel injured by atomic or chemical attack or "germ warfare" is also discussed in these classes. Various types of equipment for protection from chemical warfare agents are demonstrated including large units and individual kits, special hypodermics, an instrument for detecting dangerous gases, and some dosimeters. On smaller ships without permanent classroom space the displays and teaching aids must be portable and dismountable. A maximum class size of 15 is recommended for first-aid lectures. The services of amateur photographers in the fleet have been enlisted to make teaching films on first-aid subjects.

COMMENT: No additional information about equipment for protection against chemical warfare agents was given in this very general article.

4. Educational Levels of Soviet Naval Personnel

SOURCE: S. G. Gorshkov, Fleet Admiral, Member of the Central Committee of the Communist Party, Hero of the Soviet Union, Twenty-third Communist Party Congress and the Tasks of Naval Personnel. Morskoy Sbornik, no. 5, 1966, 3-11.

Some interesting facts about the education of Soviet naval personnel are presented. For example, more than 90% of officers in the regular navy have some higher education. All submarine commanders have some higher education, and many have college training. Two-thirds of unit commanders have college degrees. The percentage of engineering and technical personnel in naval service has increased to more than one-half of the officer corps at present. Ninety percent of the officers are Communist Party and Young Communist League members, while one-fifth of Soviet sailors are Party members. The quality of naval inductees improves annually. Today the number of young seamen with secondary education is twice as great as the number 10 years ago: 91% of seamen and petty officers have either some higher education, or a secondary or incomplete secondary education. Eighty-four percent of young seamen enter the Navy with technical specialities sufficiently developed that they may become good naval specialists in a short time. [JS]

5. The Kirov Submarine School

SOURCE: Soviet Military Review, no. 12, 1966, 10-13 (in English)

This article describes the submarine cadet training program in the Kirov Submarine School, the oldest Soviet naval college. Thirty-two graduates of the School have been awarded the title of Hero of the Soviet Union.

The school boasts first-class equipment, some of which has been designed and constructed by the cadets themselves. In the past few years, officers and cadets have developed about 400 training aids, 600 working models, tens of trainers, and several completely outfitted classrooms.

Submarine cadets learn to dive in light suits and escape from a sunken submarine through torpedo tubes. Under the direction of an Ensign Lipchan, cadets in light suits are taught to surface from a sunken vessel. Fig. 1 shows the diving suits used. Fig. 2 shows a scuba-diving exercise. Other exercises include

Fig. 1. Light diving suit used by cadets

Fig. 2. Scuba divers during a tactical exercise

training cadets to keep a sinking vessel afloat under the direction of an Ensign Bulakov. A sonar classroom designed for 30 operators is used to train cadets to distinguish underwater sounds. Their performance is monitored on a central control panel. The school also boasts a naval museum. No further training details are given. [CD]

6. Expanding the Skindiving Program at Soviet Naval Academies

SOURCE: Levshin, S. A., Developing underwater sport [skindiving] in naval training schools. Morskoy sbornik, no. 2, 1966, 68-70.

Recommendations for expanding the underwater sport program in Soviet naval training schools are made, including training of instructors, organization of lessons, and competitions to popularize the sport. In addition to the shortage of swimming pools, many schools, such as the Naval Academy imeni M. V. Frunze, lack skindiving equipment such as swim fins, snorkels, depth gauges, portable oxygen equipment, etc. Training for diving should begin with general physical preparation in the first and second years of naval school. The cooperation of the DOSAAF Naval Club [an organization serving all the armed forces] has enabled more than 100 cadets at the Frunze Academy to earn the rank "Underwater Sportsman". The club loaned a training ship in which the cadets made seven practice excursions in the Gulf of Finland and Lake Ladoga. A four-point program for expanding skindiving at naval academies would include: 1) training in all forms of underwater sport, 2) training instructors and judges for competitions, 3) scientific and technical work on theoretical and practical aspects of skindiving, and 4) publicity and exchange of information among diving groups.

COMMENT: "Underwater sport" in this context seems to be mostly skindiving, as opposed to deep diving in pressurized suits, although this distinction is not expressly stated in the article. [JS]

7. Underwater Sport Regulations

SOURCE: V. Menshikov, Underwater sport: rules and practice. Sovetskiy Patriot, 21 December 1966, p. 1, cols. 1-4.

The need for revision of the present rules regulating underwater sport competition is examined. The number of different types of prohibitions and limitations on the use of technical facilities should bereduced and requirements adjusted for experienced and novice aquanauts. The requirements concerning breathing tubes

(unnecessary in competition), buoy rope and signal buoy specifications, and the use of only standard model breathing apparatus hindered development of underwater sport. One expedient requirement is suggested -- that the construction and utilization of equipment and safety devices must provide for the safety of the sportsman in training and competition. Use of new technical devices is also limited by certain rules: that equipment dimensions cannot exceed certain amounts which restrict the speed of the sportsman, that pressure in the aqualung cylinders is limited to 150 atm, and that only one search line not exceeding 15 m is permitted, etc. Revision is required in prestart inspections (underwater searches in 1966) when the judges check all equipment. Aquatorium requirements for competitions, and the nature of construction of equipment for the intervals are insufficiently reflected in the present rules. The need for a special handbook on equipping intervals based on experience and the necessity for more concrete definition of rules concerning judicial college activities and special limitation of the rights of sportsmen guaranteeing uniform competition conditions and preparation time for them are noted. [SW]

8. School of Underwater Work

SOURCE: Zolnierz Polski (Poland), 7 November 1965, p. 10, col. 4. (Summary)

In this new Moscow school, young boys learn the diving trade, including underwater welding and metal cutting, building, ship repairing, and escape from shipwrecks.

9. Soviet Skindivers

SOURCE: S. Krasnosel'skiy. Sovetskiy Patriot (USSR), 15 December 1965, p. 3, cols. 1-4. (Summary)

The article discusses some of the activities of the amateur marine club of the Moscow Aviation Institute, which has more than 100 members.

10. Aquanaut School

SOURCE: Soviet Union (USSR), no. 191, 1966, pp. 26-27. (Summary)

Halftones show training sessions at the new school for divers of the Central Marine Club of the USSR. After graduation, divers take jobs at shipyards, sea ports, and hydroelectric projects.

11. Need for Soviet Undersea Research Stressed

SOURCE: Voyennoye znaniye (USSR), no. 3, 1966, pp. 43-44. (Summary)

In an article concentrating on French undersea research, V. Stashevskiy states that more attention should be given to this field in the Soviet Union. In 1957 underwater sport was organized by the DOSAAF Naval Clubs. Stashevskiy, however, stresses that there is a great need for the establishment of an undersea research center oriented toward science as well as sport, and recommends that this project be undertaken by the USSR Academy of Science or by the State Committee on Science and Technology.

12. Underwater Studies

SOURCE: Sovetskiy Patriot (USSR), 20 March 1966, p. 2, cols. 1-4. (Summary)

V. Stashevskiy, Secretary of the Federation of Underwater Sport of the USSR, writes that the time is ripe to create a single center of underwater studies with a designing office.

Section III. The Sealab Program, Diving Technology, and General Problems of Underwater Physiology

1. Soviet Sealab Experiment

SOURCE: Pravda (USSR), 28 August 1966, p. 6. (Summary)

A Donets physician, A. Khayes, has recently participated in a sealab experiment off the west coast of a Black Sea peninsula. The steel plate laboratory, 3 m^2 in size and provided with illumination and a lock, was at a depth of 11 m. The first few days were tolerated well and some investigations on the effects of high pressure on the human organism were conducted. An engineer from Moscow, D. Galaktionov, later joined the physician. Two half-tones show Khayes prior to submerging and the underwater laboratory. [CD]

2. Seven Days in an Underwater Home

SOURCE: Sovetskaya Rossiya (USSR), 4 Sept 1966, p. 4, col. 2-4.

Three skindivers, A. Khayes (surgeon), D. Galaktionov (Moscow engineer), and Yu. Sovetov (Donetsk timberman) spent a total of seven days, beginning 23 August 1966, in a "home" 11 m beneath the Black Sea. The "Ikhtiandr-66", consisting of one room (about 4 m^2, full height) was held down by a cement block foundation and was equipped with four portholes in the walls and roof, electricity, telephone, wooden floor, plank-bed, table, and other fittings. Air was pumped by a compressor on shore and temperature was plus 23-24°. There was no room for pumping water: water pressure is equalized with air pressure. In the first communication, Khayes indicated that he felt normal and that air was entering continuously. The doctors, who examined Khayes before descent, were interested in changes in the organism under the conditions of increased pressure in the "home." Psychotechnical tests underwater showed some changes in the organism: delayed reactions, lowered work capacity, and disruption of work of the vestibular analyzer. During the first day, Khayes was visited by laboratory worker R. Radchenko with a box of medicines for analyses; took a swim using aqualungs and caught fish for dinner; and was joined in the evening by D. Galaktionov. At night they swam to the edge of the sand, descending to 14 m and using the whole supply of air in the aqualungs. Prior to his ascent toward the end of three days, Khayes

was replaced by Yu. Sovetov. Decompression was accomplished by a 2 hr breathing of a helium-oxygen mixture, followed by a slow ascent with two 20 min stops at 7 m and 3 m. Examinations of Khayes by chief doctor Ya. Brandis and his helpers in the physiological and biochemical laboratories indicated no deviations from normal, except for some dizziness, apparently from rocking of the "home" caused by bad weather. Bad weather and poor visibility in the water forced Yu. Sovetov to ascend the following morning. This experiment was undertaken by members of the Donets club of underwater investigations "Ikhtiandr", mostly doctors from the regional T. B. dispensary and engineers from the Donets Institute of Technical Cybernetics and Mining Mechanics. Equipment was acquired through a local council and trade union. While conclusions on the scientific value of the experiment are premature, the support of scientific organizations and the help of technology and special literature are clearly indicated.
[SW]

3. Comments on "Ikhtiandr-66"

SOURCE: Soviet Life, Feb 1967, p. 3, col. 5. (verbatim)

Amateur aqualungers tried underwater living at Cape Tarkhankut on the Crimean coast. They trucked in a house of steel which was lowered some 30 feet into the Black Sea. Alexander Khayes, a Donetsk physician, lived for several days in the underwater house. The purpose of the experiment was to examine the reactions of the human organism. Khayes felt fine. The first two days he took walks in an aqualung. The third day Dmitri Galaktionov, a Moscow engineer, called on him. The visit was a prolonged one because a storm broke out. The underwater house stood up well under the storm. The aquanauts spent a week in their underwater dwelling. Their findings showed that reactions slow down, efficiency decreases and the operation of the vestibular apparatus is somewhat disturbed. "Still a man can live underwater and feel pretty good," Dr. Khayes said after

he surfaced. His partner was of the same opinion. Longer underwater experiments are scheduled.

4. Useful Undersea Research Vessel

SOURCE: Science and Engineering (USSR), 13 May 1966, pp. 6-8. (Summary)

Victor Korotkov, head of the underwater research section of the Atlantic Research Institute of Fisheries and Oceanography, together with senior engineer Vadim Martyshevsky, has used the "bathyplan" Atlant-1 to make more than 80 dives in the Mediterranean and Baltic Seas, and in the Atlantic off the coast of Africa. The bathyplane, which will be used once again this summer in the Red Sea and Mediterranean, is an undersea craft resembling a small plane, with short wings and tail control surfaces. The craft is maneuverable and can dive to 200 m. It is towed by a cable which is also a communications link with the mother ship. The chemical air purification system in the bathyplan is good for 24 hr. The Atlant-1 can surface independently if the cable snaps. In the past it has been used to study trawl operation: in the future it may be used to perfect sonar detection of schools of fish. From its undersea vantage point the bathyplane can determine the correctness of echo soundings, eventually compiling a guide to these tricky measurements.

5. A Deep-Water Bathyscaph

SOURCE: Nauka i tekhnika (USSR), no. 4, 1966, p. 23. (Summary)

Workers of the Institute of Marine Fisheries and Oceanography are studying marine life in the Barents and Norwegian Seas with the aid of a deep-water bathyscaph equipped with five portholes, still and movie cameras, television, hydroacoustic and other equipment. Institute personnel are also developing a three-compartment laboratory which can accommodate five observers simultaneously. A bathyscaph equipped with powerful searchlights, 15 portholes, and mechanical manipulators is under construction in Leningrad.

6. Soviet Sealab—"Sadko"

SOURCE: Deryugin, K. Pravda (USSR), 26 October 1966, p. 6, cols. 1-5. (Summary)

Recently in the Black Sea near Sukhumi, a group of Soviet scientists completed a month-long experiment at 25 m in a sealab called "Sadko." The Sadko was designed and built by the Underwater Research Laboratory of the Leningrad Hydrometeorological Institute in conjunction with the Acoustics Institute of the Soviet Academy of Sciences. The sealab is a sphere 3 m in diameter, displacing 13.5 tons and designed to hold 2 men. A block-and-tackle system was used to attach the Sadko to an anchor weight on the sea bottom, with one line leading to a surface buoy. Air and electricity were supplied from the R/V Nerey and from the shore. The Sadko is equipped with everything necessary for long-term scientific investigations and normal rest. High-calorie meals in special containers were brought to the sealab by scuba divers. There is a porthole for visual observations and a hatch in the "deck" for diver access to the sea. Besides personnel from the Underwater Research Laboratory, crew members from the Nerey also participated in the experiment. The divers underwent lengthy decompression in a large chamber aboard the ship. The following personnel took part in the project: project chief senior engineer A. Mayyer, ship's captain V. Krivizhenko, laboratory coworkers V. Dzhus, A. Ignat'yev, T. Kunets, V. Burnashov, V. Merlin, N. Nemtsev,

V. Grishchenko, G. Chulimov, I. Andreyev, A. Strashnov, and others. Telephone communication with the sealab permitted continuous checking of the status of the sealab crew. Doctor-physiologist Ye. Korotayev kept the sealab crew under constant observation. It is stated that the Soviet "aquanauts" have proven the feasibility of using sealabs in offshore areas to depths of 200 m. It is mentioned that next summer, a group from the Underwater Research Laboratory will perform more extensive research in the Sadko at depths to 50 m. A photo of the Sadko sealab accompanies the article. [LB]

7. Soviet-Designed Bentos-300 Sealab (USSR)

SOURCE: Izvestiya (USSR), 16 September 1966, p. 4, cols. 5-7. (Summary)

The article briefly describes the Bentos-300 sealab designed by the Giprorybflot Institute in Leningrad. The Bentos-300 has a submergence depth of 300 m, carries a complement of 10 men, and has a long bottom time. The primary working area is the observation compartment, which is equipped with television, still, and motion-picture cameras. Other facilities include comfortable living quarters, a general-purpose compartment (wardroom), a shower, a radio, and a special sea-access trunk for scuba divers. Institute Director V. Ye. Astakhov states that a special ten-man escape chamber has been incorporated into the design. In case of emergency, this chamber detaches from the Bentos-300 and rises to the surface. It is further stated that the Bentos-300 will be used for research along the continental shelf area. A drawing of the vehicle accompanies the article. [LB]

8. Research Submarines

SOURCE: Technical Digest (Czech), no. 7, 1966, p. 558. (Verbatim)

Two Soviet research submarines capable of descents down to 300 m are to enter service shortly. "Tinro" 1, with a crew of seven, is to serve the Pacific Fishery and Oceanographic Institute. This craft has a considerable submerged cruising range and is meant to rove

coastal waters on its own. The other vessel, "Bentos 300", is to carry a complement of six to eight men and remain submerged for protracted periods on more or less stationary locations.

9. Polish Bathyscaph

SOURCE: Czata (Poland), 7 May 1966, p. 6, col. 1. (Summary)

A two-man, patented propeller-driven bathyscaph for scientific research, underwater filming, shipwreck-salvage operations, and study of underwater animal life has been built in Gdansk, Poland. It carries oxygen and compressed air, which are stored in cylinders for breathing and emergency surfacing, respectively.

10. Underwater Experiment in Czechoslovakia

SOURCE: Junge Welt (E. Germany), 26/27 February 1966, p. 4, col. 1. (Verbatim)

Several divers of the Ostrava mines rescue service will spend one week underwater in cylindrical tank five meters high and three and a half meters in diameter. This experiment, conducted under medical control, will help further investigations of the behavior of the human organism during prolonged periods in so-called air bubbles under superpressure, as sometimes occurs in flooded mines. The behavior of the divers will be televised half an hour every day by the Czechoslovak television service.

11. Soviet Underwater "Glider"

SOURCE: Tygodnik Morski (Poland), 22 May 1966, p. 12, col. 4. (Summary)

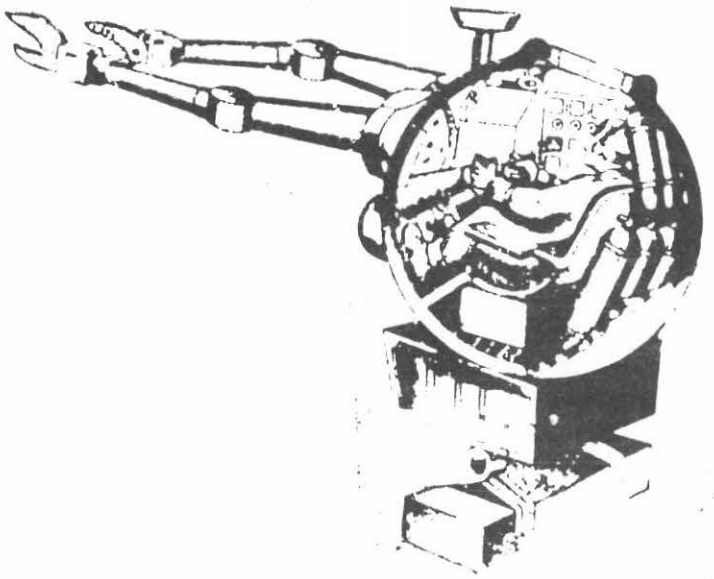
A towed underwater "glider" with transparent front and a motion-picture camera, intended for investigating

the phenomena taking place under ship bottoms, has been built in the USSR. The man piloting the craft lies dressed as a skin diver.

12. Manned Robot-Diver

SOURCE: Robot-Diver, Nauka i tekhnika, no. 10, 1966, p. 38.

A manned device for working offshore oil deposits at depths too great for a suited diver is described (see figure). Dubbed the "bathyandrome" by Soviet



engineer A. N. Dmitriyev, the device consists of a hermetic sphere approximately 1 1/2 m in diameter with an entrance lock and powerful lights. As distinguished from the true robots manufactured in other countries for undersea exploration, the bathyandrome is habitable. Two hydraulically operated mechanical hands are used for underwater work. Grippers are provided to fasten the sphere to the ocean floor and water jets are provided for locomotion. The operator sits in a comfortable armchair and communicates with the surface or with other, similar underwater craft by means of a special sonar communication system.

COMMENT: No additional information is contained in the brief original article: i.e. there is no mention of depths at which the device can operate, type of sonar communication, air and food provisions for the operator, etc. [JS]

13. Soviet Book on Underwater Technology

SOURCE: Maksimov, V. I., A. A. Novikov, and O. P. Prokof'yev. Special Purpose Submarine Fleet; the means of conquering the depths of the sea (Podvodnyy flot spetsial'nogo naznacheniya; sredstva osvoyeniya morskikh glubin). Moscow, Voyenizdat Ministerstva Oborony SSSR, 1965. 103 p.

This book, written in popular style is broken down into the following sections: 1) Introduction; 2) short history of the development of means for conquering the depths of the sea; 3) non-autonomous underwater chambers designed for great depths including hydrostats, bathyspheres, and underwater robots; 4) autonomous underwater chambers for great depths including bathyscaphes, scientific research submarines, mesoscaphes, and underwater chambers for shallow waters; 5) literature. The Western state-of-the-art in these areas is discussed in greater depth than the Soviet state-of-the-art.

In a brief discussion on the history of diving, the research of Keller et al is summarized relative to his theory concerning nitrogen narcosis. Contrary to the then widely held belief that this condition was caused by the sudden saturation of blood by nitrogen, Keller held that it was caused by oxygen under high pressure and an elevated blood CO_2 level. On the basis of this hypothesis, Keller developed new gas mixtures for diving purposes and himself executed a series of dives to 300 m, surfacing in record time (155 m in 45 min).

G. I. Danilenko's hydrostat (1923) is shown in Fig. 1.

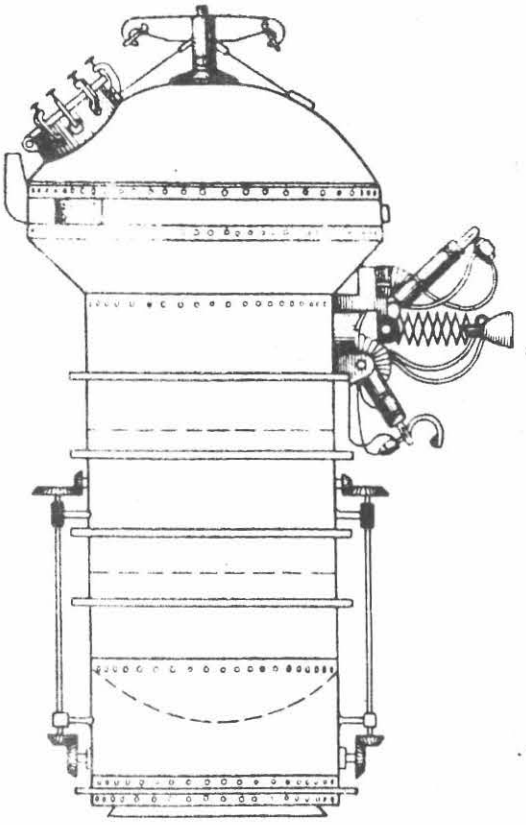


Fig. 1. Hydrostat designed by Danilenko

The later, autonomous hydrostat weighing 600 kg and designed by Yu. A. Shimanskiy (1937) is mentioned as being designed to submerge to a depth of 2500 m for 10 hr. Later (1944), the GKS-6 hydrostat was built by A. Z. Kaplanovskiy (Fig. 2).

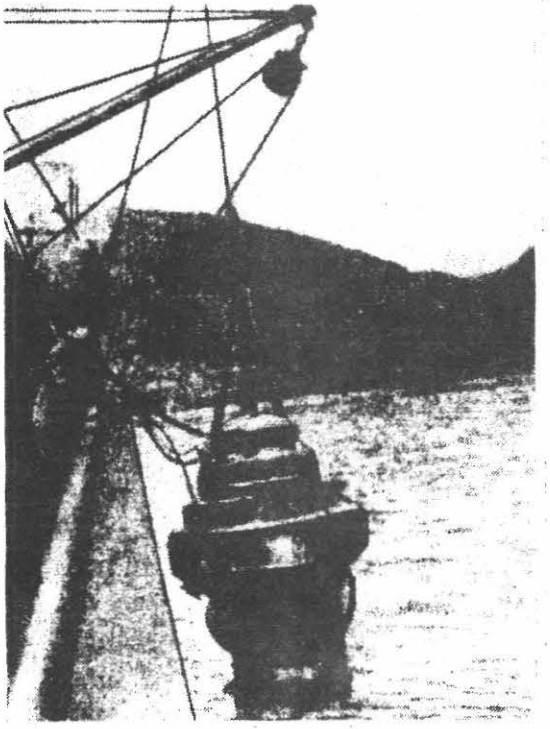


Fig. 2. GKS-6 hydrostat used at 70 m depths (designed for 400 m)

In 1957, the GG-57 hydrostat was built (Fig. 3). It was designed for depths up to 600 m. The components

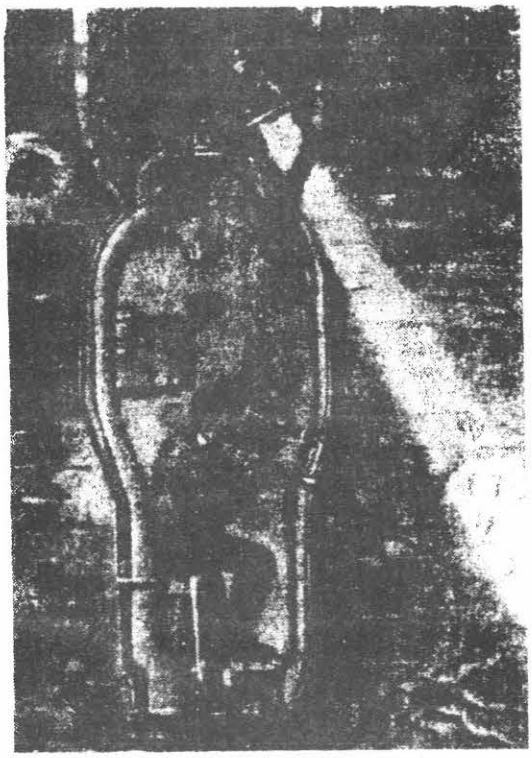


Fig. 3. External configuration of the GG-57

of this hydrostat are shown in Fig. 4.

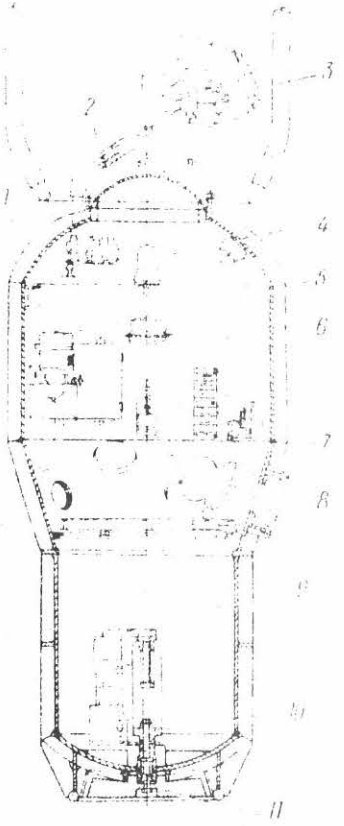


Fig. 4. Internal instrumentation of the GG-57 hydrostat.

1 - welded steel hull with external supporting fins; 2 - lock; 3 - rotating projector and lamp; 4 - cable gear; 5 - electric oil pump for the hydraulic system used to rotate the projector; 6 - compass; 7 - camera on rotating swivel; 8 - port hole; 9 - swivel stool; 10 - device for ballast release; 11 - iron ballast

The bathyscaphe built by Soviet engineers Mikhaylov, Nelidov, and Kyustler in 1936-1937 was designed for a depth of 600 m and was used for scientific research in the areas of oceanology and icthyology.

Figure 5. shows the Soviet "Batiandr" proposed by A. N. Dmitriev. The hull is 1.5 m in diameter. The

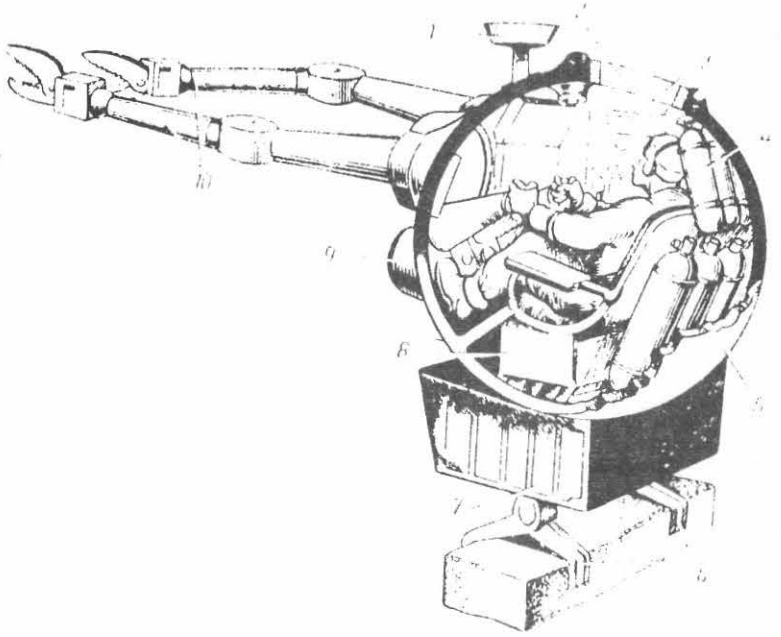


Fig. 5. Underwater robot "Batiandr"

1 - illuminator of the hydrolocator; 2 - lock;
3 - instrument panel; 4 - O_2 tanks; 5 - hull;
6 - clamps; 7 - batteries; 8 - emergency battery;
9 - projector; 10 - manipulators.

"Batiandr" is designed for use in the Pacific ocean.

Another Soviet bathyscaphe designed by V. Potapov for the fishing fleet was built in the Klayped Institute to study the behavior of commercial fish (Fig. 6).

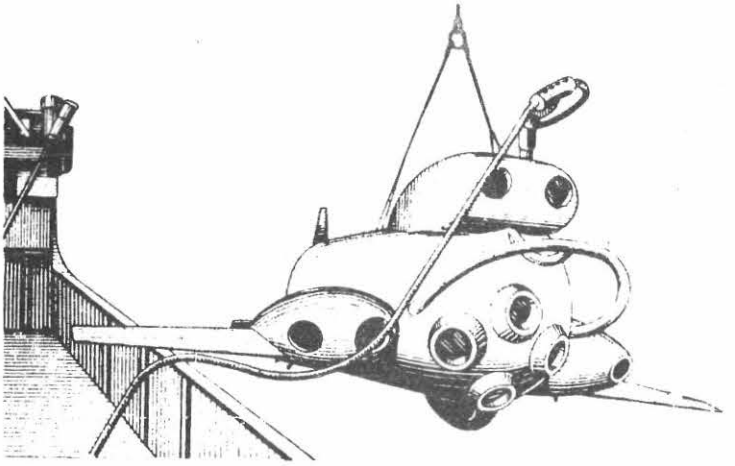


Fig. 6. Bathyscaphe built by the Klayped Institute.

This one man bathyscaphe is designed for depths of 200 m and has successfully passed a series of tests in the Baltic Sea and Atlantic Ocean.

A diagram of the "Severyanka" built by the All-Union Scientific Research Institute of Commercial Fisheries and Oceanology (commonly referred to as VNIRO) in 1958 is shown in Fig. 7. The craft was powered by

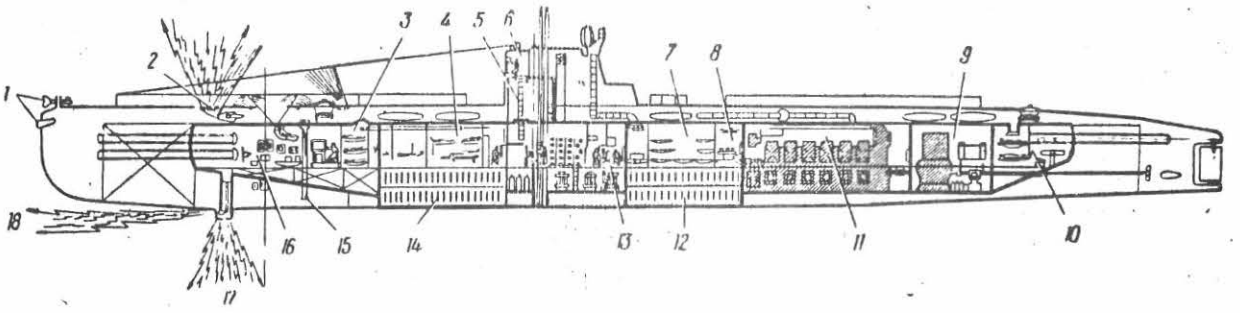


Fig. 7. Longitudinal diagram of the Severyanka

1 - Television camera and projector; 2 - upper sonar; 3 - bunks; 4 - second compartment; 5 - ladder; 6 - conning tower; 7 - 4th compartment; 8 - mess hall; 9 - 6th compartment; 10 - 7th compartment; 11 - 5th compartment; 12 - storage battery; 13 - control room; 14 - storage battery; 15 - device for probing and taking samples of the sea bottom; 16 - first scientific compartment; 17 - lower sonar; 18 - hydrolocator.

two diesels. The Severyanka cruised for 118 days over a distance of 14,500 miles and conducted 130 mission oriented dives to depths ranging from 70 to 170 m.

A new underwater research vessel, the GA-2000 (Fig. 8), is being developed by the State Planning Institute. It will have a range of 50 miles, be able

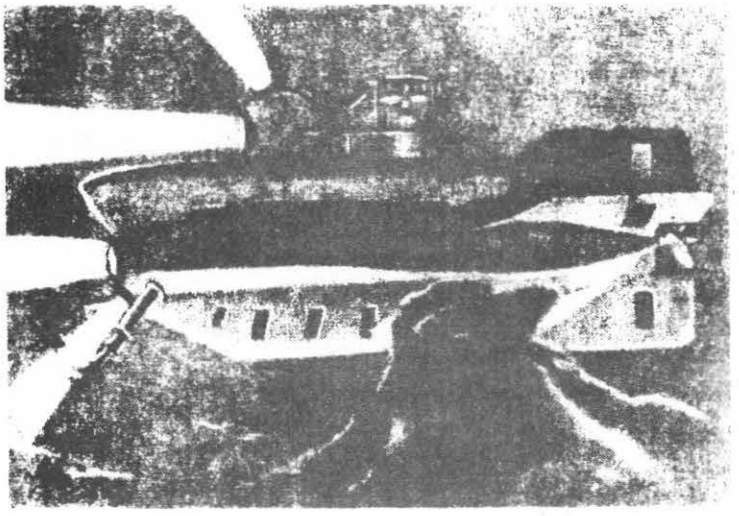


Fig. 8. The GA-2000

to submerge to 2000 m and operate for 24 hr. Its overall length will be 6.5 m, width, 1.8 m; height, 3.0 m. The steel hull is 4.5 m long and 1.5 m in diameter. The craft will be manned by a pilot and observer sitting in comfortable aircraft seats. No life support equipment is mentioned.

The concluding paragraph of this book stresses the military aims of Western (NATO) research in this area as opposed to the alleged peaceful (strictly scientific) research of the "socialist" countries.

COMMENT: No mention is made of the composition of the gas environments in any of the described craft. [CD]

14. Report Soviet Bathyscaphes Capable of Descending 7 Miles

SOURCE: FBIS (USSR & East Europe), no. 145, 1966, cc-15. (Verbatim)

Soviet scientists have designed bathyscaphes for descending to a depth of seven miles. Underwater crafts designed for Soviet expeditions include underwater automobiles and automatic laboratories to be stationed on the bottom of the sea.

15. Comments on the Soviet Sealab Program

SOURCE: Tekhnika Molodezhi, no. 12, 1966, 35-37

In this lengthy article which concentrates most heavily on Western sea lab experiments, Cousteau's in particular, some mention is made of the Soviet effort in this area. The June, 1966, International Oceanological Conference held in Moscow is also mentioned. Among the past Soviet craft mentioned are the "Severyanka" and "Sever 1." Future programs call for the use of "TINRO 1" and "Benthos 300" the later of which will have a pressure lock through which aquanauts can enter the sea. The crew of "TINRO-1" will be able to remain submerged for up to 20 days. Projects for bathyscaphes which can be submerged to 11,000 m are being planned in scientific research institutes (not specified). One such bathysphere has a 2 m diameter and can hold a 2 man crew plus research instrumentation. It can remain under water for a day. Another device consists of 2 spheres, one for the crew, and the other for remotely controlled instruments. (No figures). [CD]

16. Determining the Optimum Colors for Ships' Boiler-room Components on the Basis of Physiological and psychological requirements

SOURCE: N. Yu. Ivanov, Physiological and psychological considerations for the color of boiler rooms on ships. Sudostroyeniya, no. 1, 1966, 67-70.

Principles of using color to improve the working conditions in boiler rooms are discussed. It was concluded that the best main color for boiler rooms on ships is a cool, light color of low saturation, such as blue, blue-green, or grey-blue. The color tone selected from one of these groups should have a wavelength of 550--470 nm, coefficient of reflection of 70%, and degree of saturation of 5--25%. The reasons for selecting blue-green-grey tones as dominant colors are numerous: 1) they provide a good background for discrimination of the red and yellow colors used for signal and warning devices, 2) they provide a quiet, nondistracting background for the various types of activity conducted in boiler rooms, 3) they help decrease the discomfort factors of heat and infrared radiation common in such locations, 4) they help diminish autonomic disturbances during motion sickness, 5) they are a visual aid in

crowded boiler rooms and 7) they improve the general level of illumination. Blue-green (or turquoise) tones also soften the yellowish character of incandescent light. In addition, blue is the favorite color of many people and blue-green tones make a pleasant background for human skin. Final recommendations for a complete boiler-room color scheme in various types of ships will be up to the discretion of industrial interior decorators. A tentative color scheme is given in the accompanying chart.

Table 1. Optimum colors for boiler-room components on diesel ships

Ceiling	Bluish-white
Bulkheads and sides of ship	Light blue with coefficient of reflection (ϱ) = 60--70% (ϱ - 40--50% for sides of the ship below waterline
Decks	Grey-blue, grey or green, ϱ = 20--25%
Main and auxiliary engines	Blue-green, ϱ = 65--70%
Fittings and pipes (oil and fuel systems)	Tag colors, with ϱ = 10--30%
Control panels	Sand color, ϱ = 60--65%

Selected References

14. Matsevich, L. M. Experimental study of the allocation of attention among machine- and boiler-room crews on ships. Voprosy psikhologii, no. 5, 1964.

15. Matsevich, L. M. Physiological and hygienic appraisal of the effect of infrared radiation on members of machine-room and boiler-room crews on ships. Gigiyena truda i profzabolevaniya, no. 11, 1964.

17. Matsevich, L. M. Normalizing the temperature of heated surfaces in machine rooms and boiler rooms on ships. Morskoy flot, no. 12, 1964.

NOTE: The bibliography does not include Western sources or older, basic works on the functional use of color.

[JS]

17. Military Divers

SOURCE: Starshina Serzhant, no. 10, 1966, p. 20

The figure below shows a private Bogdanov having located a sunken towline in a deep river after two hours of activity. No description of the diving suit is given.

18. Soviet Diver Receives Gold Medal

SOURCE: VDNKh SSSR. Infcrmatsionnyy Byulleten', no. 8, 1965, 4-5.

This article summarizes the achievements of the veteran salvage diver N. Kh. Kosopulo. [CD]

19. Photograph of a Military Diver

SOURCE: Yakovlev, A. Voyennyy Vestnik, no. 1, 1967, p. 83.

This article eulogizes the military engineer-divers who investigate the underwater supports of bridges. In the photograph, their leader, formerly 1st lieutenant N. Alexeev, now commander of engineering company, is shown giving final instructions to the divers before submerging. No description or explanation is provided of the back pack worn by the diver shown below. [SC]

20. Transplantation of Crabs by Divers

SOURCE: Soviet Patriot, 30 Nov 1966, p. 4, cols. 6--7.

Members of the Moscow Club of Underwater Sport "Dolphin" have transported large fareastern crabs to the waters of the Barents Sea, specifically in the Kol'ska Gulf, Motka Bay, and Mocha, Yeyna, and Motov Gulfs. Members of the expedition were V. Kledenov, V. Belyayev, A. Murakhim, V. Stranin, Yu. Ivanov, and A. Yakovlev. [SC]

21. Underwater Telephone Device

SOURCE: AN SSSR. Institut okeanology (Institute of Oceanology) Trudy, 1965, v. 74, pp. 82-84.

An underwater telephone device with transistor amplifier, intended for wire communication with divers working underwater on stationary objects is described. The submerged loudspeaker-microphone consists of a high frequency 2 watt amplifier assembled on 5 semiconductor triodes, 2 loudspeakers (Gr-1 and Gr-2), storage batteries, and coils with a cross connection.

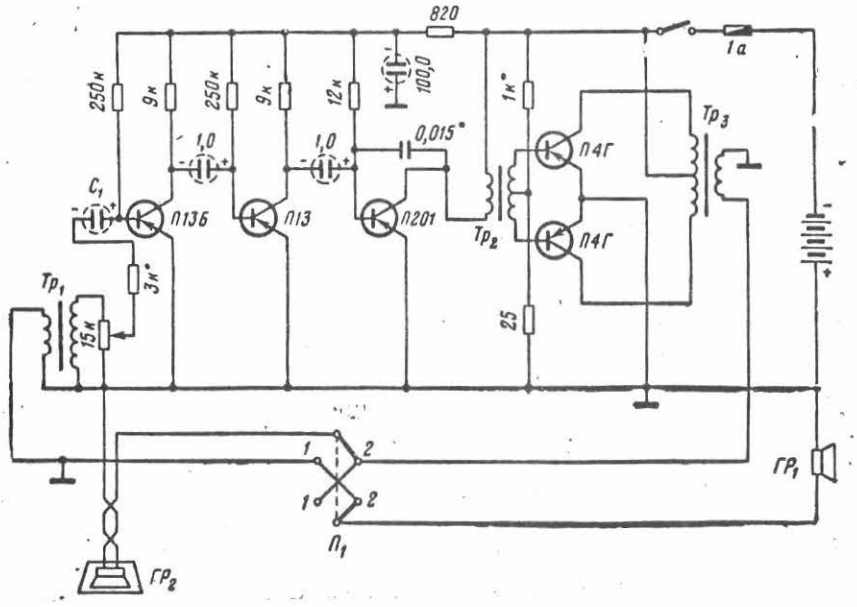


Fig. 1. Principal electrical system of the underwater telephone device.

The Gr-1, connected at the amplifier input serves as a microphone; the Gr-2, connected at the amplifier outlet,

serves as a telephone. Their roles change when the switches are reversed. Two P4G, two P3 triodes, and one P201 triode are used in the amplifier; the 1GD1 type dynamics are used for the loudspeakers; and four STsS-12 batteries provide continuous (100 hr average) operation. The submerged Gr-2 is installed in a clyndrical boxing filled with castor oil. The loudspeaker is connected with the above-water block by 2 cores of common wiring (type PMVG). The amplifier, storage batteries, and Gr-1 are enclosed in a box case. A coil with a lead which connects the Gr-2 with the amplifier is fastened on the back box lid. A sliding contact on the coil premits unwinding and winding of the lead without disconnecting the device.

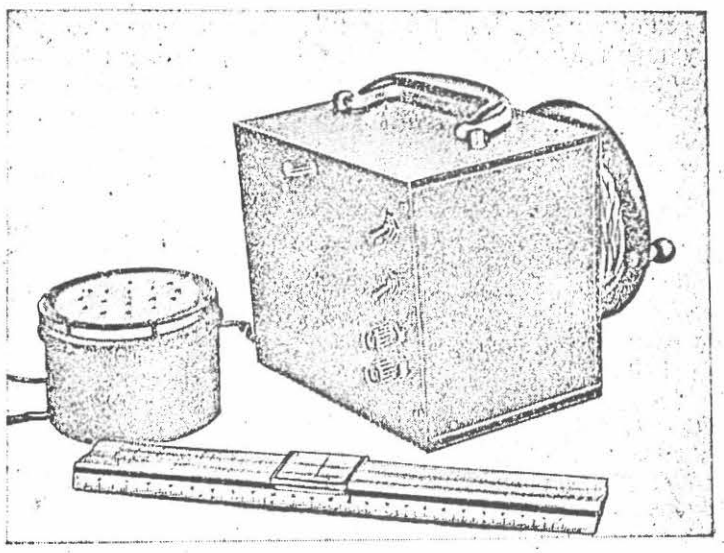
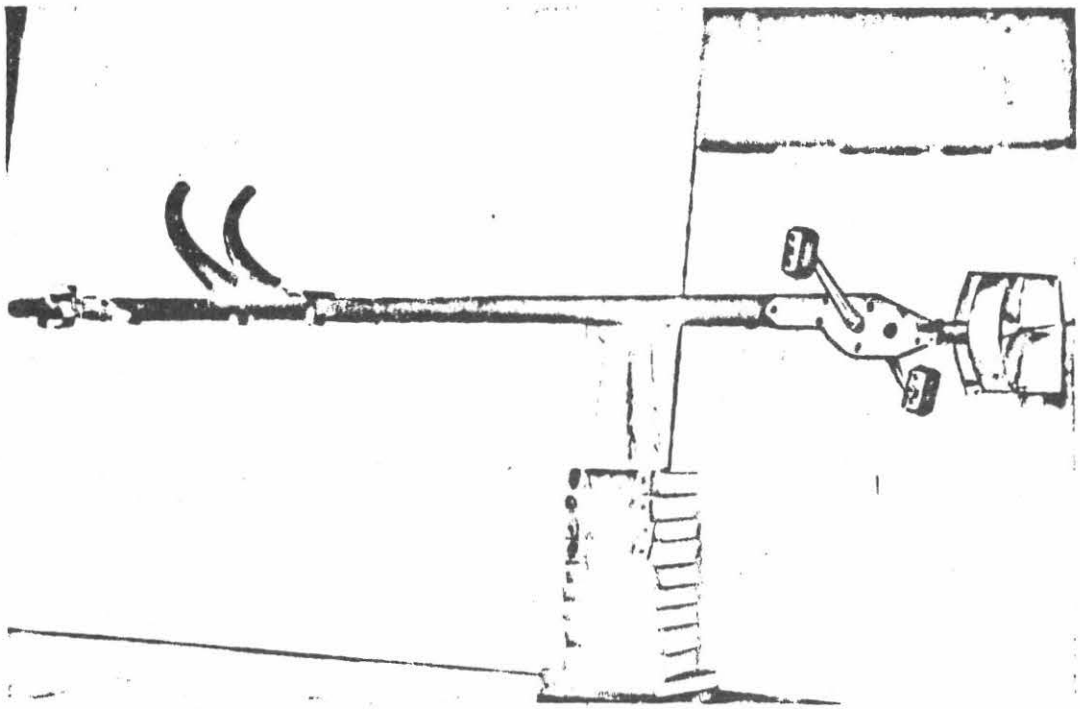


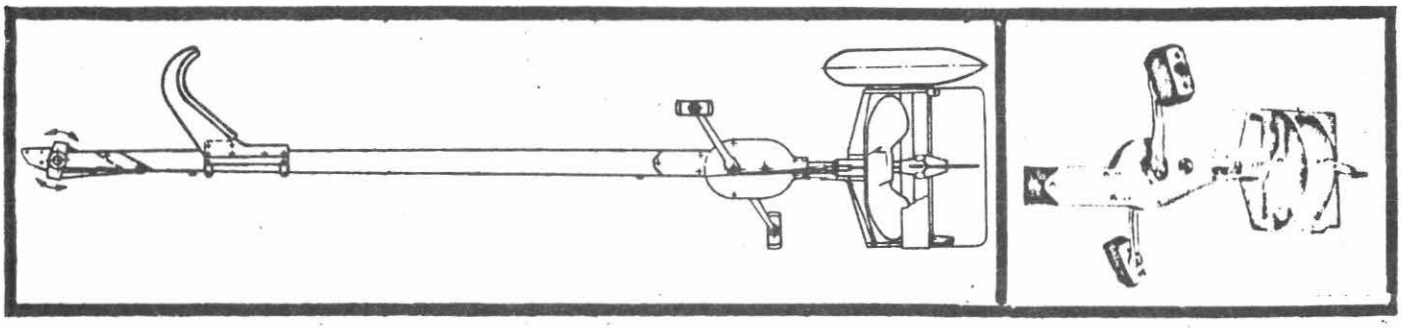
Fig. 3. External appearance of the telephone device.

Audibility and clarity of transmission were excellent in both directions (clarity was somewhat worse from below) up to a 10 m distance between loudspeaker and diver. The distance of the effect can apparently be increased by omitting the castor oil since it dampens fluctuations of the loudspeaker diffuser; however, this would necessitate equipping the internal cavity of the box with a water pressure compensating device which is inconvenient for work at various depths. Development of a new kind of mouthpiece for the aqualung is therefore suggested. [SW]

22. Underwater Velocipede

SOURCE: Yu. Belyayev. Izobretatel' i ratsionalizatov, no. 6, 1965, p. 31





The device shown in the figures above was invented by the author (Author Certificate 159120) and weighs 8.3 kg. [CD]

23. New Soviet-Made Swim Fins of Polyethylene

SOURCE: Sovetskiy patriot (USSR), 19 June 1966, 3, cols. 6-7. (Summary)

The Soviets are producing buoyant polyethylene swim fins for scuba and skin divers. The fins weigh 300 g each and are 410 mm long and 210 mm wide with strengthening ribs in the toe portion. The heel portion is similar to an overshoe with a buckle which makes the fins adjustable from size 36 to 46.

24. Apparatus for Underwater Swimming

SOURCE: Izobreteniya, promyshlennyye obraztsy, tovarnyye znaki, no. 22, 1966, 165, Class 77, No. 188872

The swimming device shown in Figure 1 is distinguished by the leg band which is loosely connected to the foot clamp for comfort during swimming.

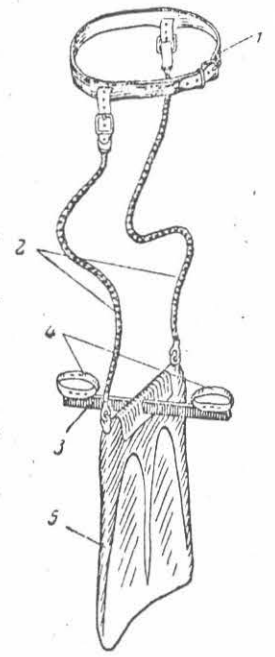


Fig. 1.
1 - leg band; 2 - flexible rope; 3 - lever; 4 - foot clamp; 5 - fin.

25. Ukraina-2 —New Soviet Aqualung

SOURCE: Mashinskiy, M. Sovetskiy patriot, 16 October 1966, p. 4, col. 7. (Summary)

At the Lugansk Rescue Equipment Plant, engineers A. Gnam and V. Prokudin have designed a new aqualung, the Ukraina-2. The lung is intended for use at depths up to 40 m and weighs 19.8 kg with two 7-liter tanks. The demand regulator and reduction valve weigh 1 kg. The reduction valve, mounted on the tanks, provides primary pressure reduction from 150 atm to 6--7 atm. The demand regulator and mouthpiece are a single unit connected by a rubber hose to the reduction valve. Air pressure through the demand regulator is up to 10—15 mm of a water column under normal swimming conditions. Tanks of various capacity may be used with the reduction valve —regulator set. Unlike the AVM-series aqualungs which give a sound signal prior to air depletion, the Ukraina-2 is equipped with an emergency reserve-air lever. A quick-release clasp is also incorporated into the design, and efforts have been made to reduce overall weight and the frontal drag of the tank valve system. Master of Sport Grigoriy Lysenko took first place in recent Soviet scuba competition using the Ukraina-2. A photo accompanies the article. [LB]

26. Comment on the Ukraine-2 Aqualung

SOURCE: Mazurov, I. "Sovetskiy Patriot". 30 Nov 1966. p. 3. cols. 5-7 (Summary)

This year the "Ukraine-2" aqualung was designed. Difficulties in its construction were overcome by such underwater sport enthusiasts as A. I. Gnamm, M. Z. Marin, and V. F. Prokudin. There is yet no diving suit similar to the "Calypso". [SC]

27. Breathing Device for Divers Working at Constant Depths. Class 65, No. 187553.

SOURCE: Izobreteniya, promyshlennyye obraztsy, tovarnyye znaki, no. 20, 1966, 204.

An Author Certificate has been issued for a breathing device for divers working at constant depths. It consists of a housing with a mask and inhaling and exhaling valves; it is connected to the breathing bag of the device regulating the required gas volume. The breathing bag has a bleeder valve joined to a regenerative cartridge containing a chemical substance, and to a cartridge containing a chemical absorbent. To insure that the diver can remain under water at constant depths for a long period, the component regulating the required gas volume in the breathing bag is in the form of a housing with channels. The housing is joined to the exhalation tube by a regenerative cartridge and a cartridge containing a chemical absorbent. The housing contains a valve rest contacting an elasticized membrane mounted inside the housing and attached to the elastic walls of the breathing bag by flexible trip rods. The housing automatically distributes the flow of exhaled gas to the regenerative and absorbent cartridges.

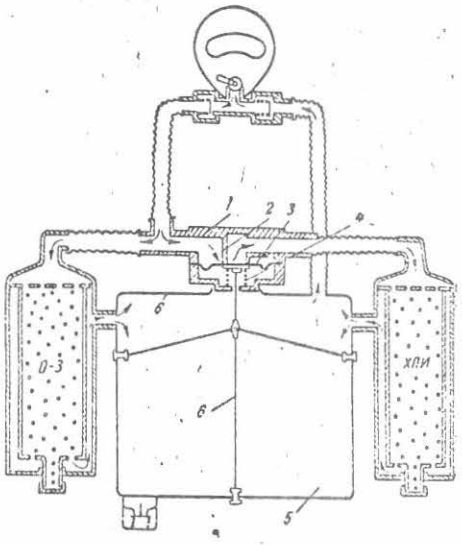


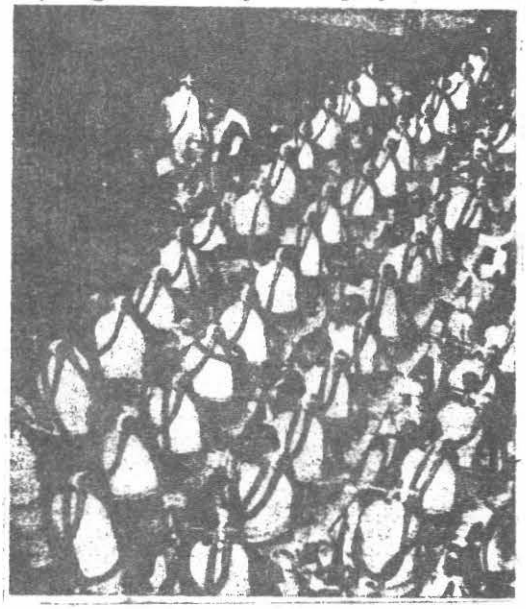
Fig. 1. Breathing device for divers.

1 - Housing of device regulating required gas volume; 2 - valve rest; 3 - membrane; 4 - spring; 5 - breathing bag; 6 - elastic trip rods.

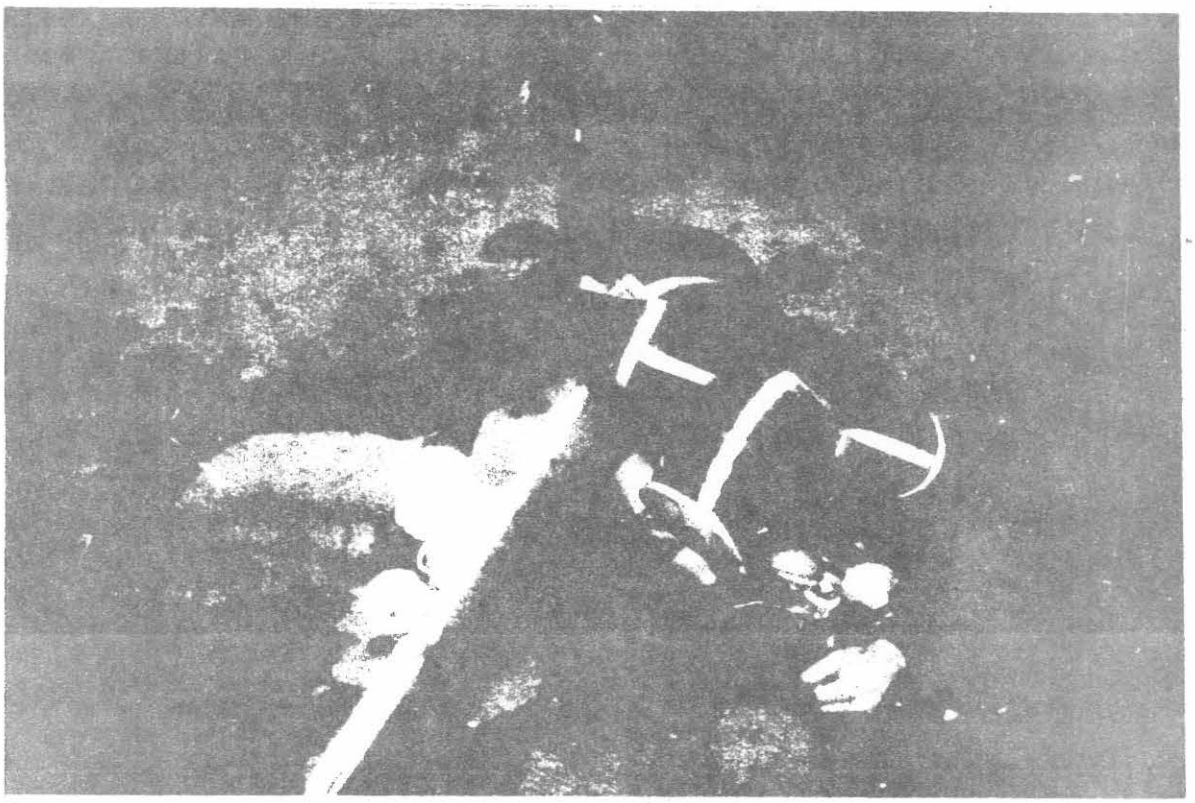
28. Manufacture of Scuba Diving Equipment in Poland

SOURCE: Hiszpanski, Jan. Morze, no. 11/432, 1966, p. 18 and 27

The Precision Mechanics Plant (Zaklady Mechaniki Precyzyjnej) in OLIWA [Gdansk Voivodship] specializes in the manufacture of scuba diving equipment. It now makes the "Mors" and "Elf" units, and works on several prototypes. Before serial production is started, all apparatus is tested extensively by professional divers, on Wdzydze Lake, where, since 1961, each July is spent in testing by a group of divers and technicians who arrive by truck with all necessary equipment. "Mors" and "Elf" (P-11) were tested there. The latter is designed for remaining under water for one hour. Wdzydze Lake is now a center for scuba diving and is occasionally visited by the Polish Navy. The Homeland Defense League (Liga Obrony Kraju) maintains a scuba



diving station on Charzykowy Lake (Jezioro Charzykowskie) nearby. Photos below show a shipment of "Elf" apparatuses ready for export and a scuba diver. [DR]



29. Effect of Inhaling Various Gas Mixtures on Brain Biochemistry

SOURCE: Prokhorenko, L. G. Ukrainskiy Biokhimicheskiy Zhurnal. Vol. 37, no. 1, 1965, 51-58 (in Ukrainian)

The author studied the content of ammonia, amide nitrogen of glutamine, nitrogen of glutamic acid and phosphorus of ATP in the brains of rats after they had inhaled gas mixtures containing methane, carbon monoxide and hydrogen. In all series of observations, an increase in ammonia content and a decrease in amide nitrogen of glutamine content was noted. Only relatively small changes in ATP and glutamic acid could be detected. [CD]

30. Gas Atmospheres for Divers and Experiments on Underwater breathing

SOURCE: S. Tsikora, A path into the ocean. Izvestiya, 13 November 1966, p. 5, cols. 2-6.

Experiments in which a mouse remained alive underwater at various simulated depths are described. The experimental apparatus (see photograph) was filled almost to the top with water well-saturated with oxygen; a steel mesh barrier prevented access to this air reservoir. It is claimed that the mouse became acclimated in 20 sec. Candidate of Medical Sciences V. Kozak was in charge of the experiment. The mouse familiarized itself with its new environment and seemed not to notice increases in pressure as it "descended" to simulated depths. A brief respiratory disruption in the 37th minute of the experiment was attributed to the additional effort required to breathe from liquid. The experimenters displayed a pertinent issue of an American biology journal and discussed similar experiments being conducted in the USA.

COMMENT: The total time the mouse remained underwater and its condition afterward are not described. No artificial bladder or any type of membrane is mentioned in the article, and there do not seem to be any membranes in the photograph.

The problem of selecting the optimum gas atmosphere for human divers working at great depths is discussed. A normal, sea-level atmosphere has deleterious effects on the human organism at undersea pressures. During the record dive by Hans Keller, gas composition at 300 m was determined using a computer. Unfortunately, two of Keller's companions died during this dive due to equipment defects. This record dive showed that helium, like all the other gases tested for respiratory mixtures, has depth limitations. The only other possible constituent is the highly explosive hydrogen, which presents many problems.

COMMENT: All the information dealing with Keller in this popularized article has been treated. Nor is there any additional data about respiratory mixtures containing hydrogen. [JS]

Fig. 1. A mouse becomes an aquanaut. Researchers of the Laboratory of Hydrobionics (Institute not mentioned), Mikhail Irodov (left) and Vladimir Demchenko conducted the experiment.

31. The Role of Motor Activity During Rest Periods Following Diving

Nikitin, V. F. and I. M. Kondrat'yev. Gigiyena truda i professional'nyye zabolevaniya, no. 9, 1966, 47-48.

An experiment was made to determine the effect of rest with exercises on the occurrence of decompression sickness. The master test was used, which consists of walking up 23 cm high steps for 1 1/2 min, the number of steps depending on the age and weight of the subject. Work was calculated according to a formula presented in the original article and was found to be only 3-4 kg/m per sec. Divers aged 22 to 36 were subjected to 439 control and 112 experimental observations during work at depths of 60 to 160 m. It was found that some exercise taken during rest periods resulted in no sickness after diving at depths less than 160 m. At a depth of 160 m, decompression sickness was 2 1/2 times less frequent than without this regime. Three men predisposed to decompression sickness and who did not become sick after light exercises, were included in the postdiving rest periods. These exercises are intended particularly for parts of the lower extremities such as the knees, which appear to be more affected by decompression.

They are also recommended to improve blood circulation and to accelerate desaturation after diving. [CD]

32. Problems of Underwater Physiology

SOURCE: Sovetskiy Patriot, 29 May 1966, p. 3, col. 1-4.

Problems facing underwater investigations include preparation of aquanauts, composition of an artificial atmosphere, apparatus for aquanauts, underwater orientation, and organization of the working area and protection of aquanauts and apparatus from sea inhabitants. The stay of a group at 60 m for two weeks, during which their work coefficient of useful activity increased to 90%, and their ascent after 36 hr-decompression proves that man can overcome the obstacle of great water pressure. The necessity of using an artificial atmosphere in underwater homes presents problems. Oxygen enters the closed home from cylinders and impurities (air samples show up to 100 different gases and vapors subject to removal) are removed by special absorption apparatus. Typical submarine air purification systems cannot be used since both pressure and the effect of expelling impurities increase at greater depths. An artificial helium-oxygen gas mixture (for example, 4% oxygen, 16% nitrogen, 80% helium) is breathed. The physical properties of such an atmosphere differ greatly from the earth's atmosphere - combustion can not be maintained in an artificial gas mixture because of the small oxygen component; man freezes more severely in it than in air; and it distorts the human voice, making communication difficult. The aquanaut's apparatus consists of breathing apparatus, hydrosuit, watch, depth gage, underwater telephone device, direction finder etc. The breathing apparatus, working on a helium-oxygen mixture consists of hoses with the breathing mixture supplied from the home, or is autonomous, but in either case is a closed-cycle breathing because the expense of helium makes its use uneconomical and open-cycle breathing for a long time at a depth would require huge capacity cylinders or an extremely high pressure of the gas mixture in them. Existing hydrosuits are inconvenient and ineffective against cold water. Suits with a battery-generated heating electrical current attached to the waist are still being tested. The length of stay underwater is increased by the use of homes: one group of ten spent two weeks (totalling 100 man-hours) working in the water and two other groups of four divers each, at a depth of 55-60 m, did work in two

and a half months which would have required at least a year using the usual methods. [SW]

Section IV. Problems of Decompression Sickness (Caisson Disease)

1. Mechanism of the Development of Severe Forms of Caisson Disease

SOURCE: Vavilov, I. I. and P. M. Gramenitskiy. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas m e d i um), vol. 2, Moscow-Leningrad, Izd-vo "Nauka", 1958. 12-24.

Respiratory and circulatory changes accompanying the development of caisson disease are considered. Gas bubbles are most likely to form in the venous blood after a sharp drop in ambient pressure. However, gas bubbles may be dissolved in the blood in accordance with the Pirogov-Pashutin phenomenon, described by Brestkin. In this manner the body resists the effects of aeroembolism.

The experiments described in this paper treated changes in respiration and circulation of dogs suffering from severe caisson disease. Twenty-one dogs received morphine-ether-urethan or morphine-urethan anesthesia before being subjected to pressures of 5--6 atm (gauge pressure) for 1.5--3 hr. Compression took 3--5 min and decompression 3--3.5 min. A kymograph in the pressure chamber recorded blood pressure and respiration continuously, or at 2--6 hr intervals. The formation and movement of gas bubbles was traced in exposed abdominal veins.

Caisson disease developed clearly in all experimental animals, ten of which died. Seven dogs died 15--33 min after decompression, and two 58--60 min afterwards. The diagnosis of caisson disease was confirmed by autopsy: gas blockage of large veins and the right side of the heart prevented circulation. The other eleven dogs survived the critical period and were in no danger of death from aeroembolism, although gas bubbles were also found in their venous blood. The survival of these dogs cannot be explained by weight differences or drug dosage, but must be due to individual characteristics. Perhaps some dogs are more susceptible to caisson disease. In addition, meteorism (distention of abdomen by gas) developed differently in individual dogs and considerably affected the outcome of caisson disease.

After decompression, respiration was extremely irregular in most animals, and pulse was slower. Dyspnea

(labored, painful breathing), appearing shortly after decompression, was the most characteristic symptom of caisson disease. In some cases 160--180 respiratory movements per min were recorded. Respiratory amplitude also increased. At the same time, blood pressure increased by 20--80 mm Hg, and pulse rate accelerated. A definite parallelism between intensity of gas formation in the vascular system and the intensity of respiratory and circulatory changes was clearly demonstrated in all experiments. Gas bubbles in the veins were responsible for the symptoms of caisson disease which have been described.

In severe cases, leading to the rapid death of animals, blood pressure dropped sharply after its initial increase, and dyspnea continued until death. Much foam was discharged from tracheotomy tubes during dyspnea, indicating severe pulmonary edema.

In less violent, but also fatal cases of caisson disease, dyspnea occurred periodically. Simultaneously, large gas bubbles appeared in veins and sometimes also in small arteries. In many cases changes in cardiac rhythm and respiratory movements occurred at the same time. Changes in cardiac activity in the agonal period are apparently caused both by gas accumulation in the heart and by impulses from the central nervous system.

After circulation stopped in those dogs which succumbed rapidly to caisson disease, some pressure was maintained in the cardiovascular system because of gas accumulations in the blood. It was postulated, therefore, that the increase in blood pressure observed in live animals afflicted with caisson disease is not primarily due to physiological reactions of the organism, but rather to increased volume of the gas--blood mixture in the vascular system.

In animals surviving caisson disease, blood pressure dropped slowly and uniformly, while pulse accelerated to 220--240 beats/min 2--8.5 hr after decompression. Autopies of the non-surviving animals showed extravascular accumulations of gas in the spaces between muscles and in the joints. Evidence of hemorrhages in the lungs was found, in addition to the pulmonary edema mentioned above.

Experimental data clearly showed that gas formation in venous blood is the principal cause of functional changes occurring during caisson disease. Furthermore, these observations confirmed Brestkin's theory that gas formation is most intense in blood from fat-rich tissues. Undoubtedly, most gas bubbles move to the heart with the

blood. Some gas bubbles, of course, are broken up when blood is expelled from the heart into the pulmonary arteries and may then be absorbed. The bulk of the gas bubbles, however, reach the pulmonary capillaries. Thus, it may be concluded that symptoms of caisson disease are best explained by gas blockage of the pulmonary circulation.

Gas embolism in the pulmonary capillaries is accompanied by a reflex effect on respiration, which contributes to dyspnea. Gas blockage of the pulmonary capillaries also causes insufficient circulation, resulting in oxygen starvation.

A more detailed study of the results of gas blockage of the pulmonary capillaries and of the right side of the heart will be the subject of a further study by the authors. Future investigations of caisson disease should attempt to uncover all the body's protective mechanisms against caisson disease and find ways of intensifying them.

The development of severe caisson disease described here may be different for less severe cases. For example, in these experiments extravascular formation of gas bubbles was of secondary importance: however, this phenomenon causes itching and pain in muscles and joints among divers and high-altitude fliers. It is also possible that the symptoms of aeroembolism described here occur also in milder forms of caisson disease, but have escaped attention because they are compensated to some degree by the organism.

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2. Effect of increased tissue hydration and elevated ambient temperature on the severity of caisson disease at high altitudes

SOURCE: Brestkin, A. P., P. M. Gramenitskiy, A. N. Mazin, P. V. Oblapenko, V. V. Ogleznev and N. M. Rachkov. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), vol. 2, Moscow-Leningrad, Izd-vo "Nauka", 1958, 25-31.

The effect of two factors -- the degree of hydration of tissues and ambient temperature,-- on the occurrence and intensification of symptoms of caisson disease was studied. Animal experiments conducted by Brestkin in 1953 first demonstrated that supersaturated hydrated tissues (such as lymph and synovial fluid are less able to retain dissolved nitrogen than tissues containing less water (such as blood, muscle, nervous tissue and adipose tissue). In these experiments the effect of water and water-and-salt intake on the development of caisson disease was studied in human subjects (the authors) exposed to pressure-chamber altitudes of 11,000 m (169 mm Hg) for 60 min. Decompression took 7--10 min, and the subjects breathed oxygen throughout. One group of subjects drank 1.5 liters of water in 3--5 min within 30--60 min of entering the pressure chamber. Other subjects ate food containing 20--25 g of salt in addition to the water. Excretion of urine was measured 2.5--3.5 hr after drinking the water.

Comparison with diuresis under normal pressure

conditions showed that the diuresis curve of subjects at 11,000 m was virtually the same as that of controls Comparative tests at 5000 m ruled out a possible effect of hypoxemia on diuresis. As was expected, two to three times less urine was excreted after the water-and-salt intake than after water alone, under both normal and decreased pressure conditions. This study clearly shows the dependence of the severity of caisson disease on the degree of water retention in tissues. The more water retained in tissues, the more frequent and severe the symptoms of caisson disease. (See Table 1). Severe

Table 1. Caisson disease symptoms in men at 11,000 m after copious intake of water and water-and-salt.

Test conditions	Number of tests	Absence of symptoms	Skin itching	Skin itching and pain in joints
Without water or salt	27	2	15	10
Water intake (1.5 liters)	4	1	2	1
Water-and-salt intake (1.5 liters and 20--25 g)	14	1	4	9

pain in the joints sometimes stopped the tests. It was concluded that accumulation of water in the organism promotes the development of symptoms of caisson disease.

Another set of tests was conducted to clarify the important role of skin temperature in caisson disease. One group of subjects wore furlined flying suits for the entire test. Among the lightly-clad control subjects, skin temperature decreased before and during decompression, and increased before and during compression. Elevated skin temperature was usually accompanied by itching. The elevation in skin temperature is undoubtedly due to reflexive intensification of blood circulation in the skin and subcutaneous tissue as a result of formation of gas bubbles there. In tests

with protective clothing, skin temperature fluctuated less and remained at a higher level, and there was little itching. Rectal temperature did not vary with changes in clothing or pressure.

It is important to note that caisson disease symptoms were less severe and less frequent at low pressure when subjects wore warm clothing. In tests without warm clothing, the latent period of the conditioned reflex (at 11,000 m) lengthened, especially when caisson disease symptoms began to appear. In tests with warm clothing, the latent period of the conditioned reflex at 11,000 m was the same or even shorter than initial values. It was concluded that limiting heat transfer through the use of warm clothing is an important means of preventing caisson disease in fliers.

Summary

1. No sharply defined differences in the diuresis curves occur in man upon drinking 1.5 liters of water under ordinary conditions during a 1-hour stay at 5000 m altitude breathing air and at 11,000 m altitude breathing oxygen.

2. Upon drinking the same quantity of water (1.5 liters) with salt (20 to 25 g NaCl), diuresis under ordinary conditions as well as at high altitudes is sharply reduced as compared with that recorded after drinking water without salt.

3. A water-and-salt intake which leads to the retention of water in the organism and to more or less substantial hydration of its tissues contributes to the occurrence and development of caisson disease.

4. The limitation of heat transfer from the human body by means of warm clothing at an ordinary temperature of the surrounding air prevents the development of caisson disease at high altitudes.

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3. Supersaturated Gas-Liquid Solutions and their Significance Relative to Caisson Disease

SOURCE: Brestkin, A. P. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), vol. 2, Moscow-Leningrad, Izd-vo "Nauka", 1958. 32-45.

The apparatus used for the author's experiments on supersaturated solutions is shown in Figs. 1 and 2.

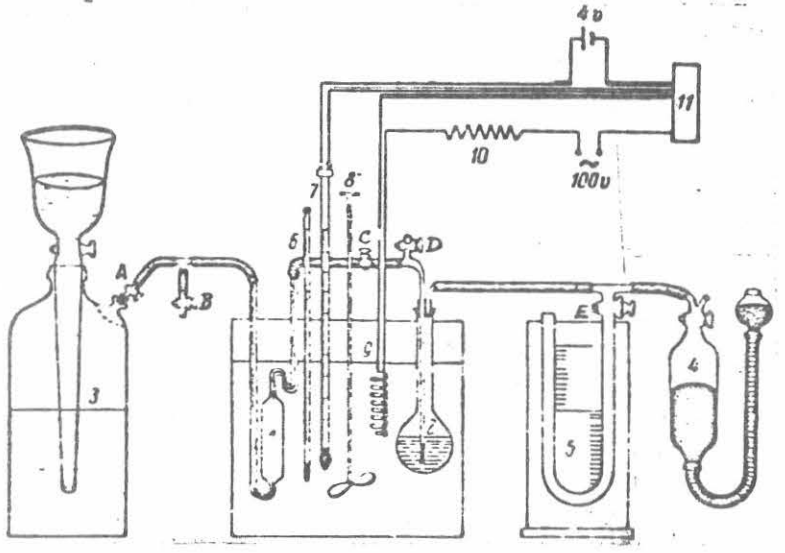

Fig. 1. Apparatus for studying supersaturated solutions of gases in liquids at low temperatures.

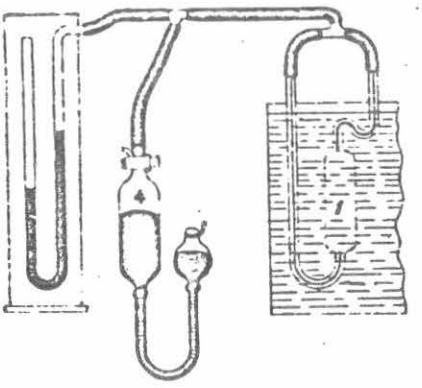

Fig. 2. Apparatus for transforming a saturated gas-liquid solution into a supersaturated one.

It consists of the setup shown in Fig. 2 using a dilatometer to determine the specific gravity of liquids. The volume of the cylindrical container is 200--300 ml with sealed, attached tubes with outer diameter of 6--8 mm and inner diameter of 1 to 1.5 mm. The length of the tubes is approximately 30--40 cm with 1 mm graduations. The dilatometer is connected to the saturator (2) and a gas meter (3) by means of rubber vacuum hoses . The saturator consists of a half liter flask with a circular bottom closed by a stopper with two openings for glass tubes, one of which reaches the bottom of the flask. Vacuum tubes connect the saturator with a mercury buret (4) and water manometer (5). Both the dilatometer and saturator are placed in a glass thermostat filled with water. The water is thoroughly mixed by an electric motor (8). Water temperature in the thermostat is maintained constant by means of an electric heater (9), a rheostat (10), a regulator (7), and mercury relay. Since experiments were conducted at room temperature (25°), it was possible to maintain the thermostat constant within $\pm$ 0.01° using a Beckman thermometer (6).

Table 1 shows some supersaturation coefficients for various gas-liquid solutions at low pressures. From the table, it was concluded that the supersaturation coefficient is dependent on the nature of the dissolved gas. A gas that is readily soluble is capable of forming more stable supersaturated solutions than a poorly soluble gas.

In experiments with rabbits, the effects of decompression were studied. A total of 17 experiments using 51 rabbits was conducted. In each experiment, three rabbits were placed into a diver's compression chamber filled with compressed air and killed after 5 hours. After decompression, the tissues of the dead animals were examined for the presence of gas bubbles. Care was exercised to ensure that all tissues of the rabbit were exposed to the same degree of nitrogen supersatura-

Table 1. Supersaturation coefficients of various gas-liquid solutions at low pressures

Solvent	Gas	p_s in mm Hg	p_m in mm Hg	p_m in mm Hg	K_1	λ in ml/ml	η in poise	σ in dyne/cm
Water	Helium	730-740	300-360	340	2.03-2.43	0.0099	0.0089	73.0
	Nitrogen	730-740	160-180	170	4.11-4.56	0.0152	0.0089	73.0
	CO_2	730-740	100-140	130	5.0-7.0	0.759	0.0089	73.0
20% NaCl. solution	Helium	730-740	400-450	430	1.6-1.82	0.0035	0.0110	78.0
	Nitrogen	730-740	200-220	210	3.4-3.65	0.00549	0.0110	78.0
	CO_2	730-740	180-210	190	3.5-4.04	0.269	0.0110	78.0
10% solution of glycerine	Helium	730-740	260-300	280	2.46-2.81	0.0082	0.0110	78.0
	Nitrogen	730-740	100-150	130	4.93-7.3	0.0132	0.0110	78.0
	CO_2	730-740	70-120	100	6.20-10.4	0.660	0.0110	78.0
0.008% solution of octyl alcohol	Helium	730-740	250-300	270	2.46-2.92	0.0102	0.0110	52.0
	Nitrogen	730-740	80-95	90	7.8-9.1	0.0161	0.0110	52.0
	CO_2	730-740	Not at 25	90	7.8-9.1	0.771	0.0110	52.0
Benzene	Helium	650	100-120	110	5.4-6.5	0.0192	0.0060	27.0
	Nitrogen	650	Not at 70	-	-	0.106	0.0060	27.0
	CO_2	650	Not at 70	-	-	2.21	0.0060	27.0

tion by making sure that all animals were killed at the same pressure.

It was observed that no gas bubbles could be detected in any tissue at pressures up to 2.8 atm since the pressure of dissolved nitrogen $p0$ at this pressure equalled $\frac{2.80 \times 80}{100} = 2.24$ atm. The external pressure p following decompression was 1 atm and the degree of supersaturation was $p0/p = 2.24/1 = 2.24$ which is still below threshold for the formation of gas bubbles in rabbit tissue.

At pressures from 2.8 to 3.0 atm, gas bubbles were detected in synovial liquid in the large articulations of the extremities, in the lymph of the mesenteric lymph ducts, in the liquid of interfascial spaces, and under

the fasciae of the muscles themselves. No bubbles were found in the blood or fatty tissues. Thus the supersaturation coefficient reflecting the maximum degree of supersaturation for nitrogen solutions in lymph and synovial liquids falls within the range of 2.24--2.4.

At pressures of 3.4--4.0 atm, large amounts of gas bubbles were found in bone marrow in addition to the above tissues. However, no bubbles were found in fatty tissues. The coefficient for bone marrow was set at between 2.8 and 3.2.

At pressures of 4 atm and more, bubbles were found in all tissues including fat. When fatty tissue was stretched out, gas bubbles could be detected by their light. Thus the supersaturation coefficient for fatty tissues was the highest, e.g. 3.2 plus. The results of this experiment were in good agreement with diving data (not cited).

The conclusions of this article were that: 1) Easily soluble gases at normal pressure form more stable supersaturated solutions than poorly soluble gases; 2) the presence of dissolved salt (20% NaCl solution in water) lowers both the solubility of gases (Sechenov's law) and the stability of a supersaturated gas-liquid solution; 3) glycerine in water reduces the solubility of gases and increases the stability of supersaturated gas-liquid solutions owing to increased viscosity; 4) the addition of a negligible amount of a surface active substance such as 0.08 g of alcohol in 1 liter of water does not substantially affect the solubility of gases but increases the stability of supersaturated gas solutions in water; 5) different tissues in the organism have a different capacity for retaining dissolved nitrogen in the supersaturated strate. Synovial, serous, and lymph fluids with low viscosity are poor solvents of nitrogen and form less stable supersaturated solutions than blood, medullary, or adipose tissues which are more viscous and are good solvents of nitrogen; 6) these differences partially explain the reason for the detection of large numbers of nitrogen bubbles in blood vessels in people or animals killed by Caisson disease.

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4. Case History of Severe Decompression Sickness

SOURCE: Korogodskiy, G. M. and A. Ya. Kapustnik (lt. colonels of the medical service). Voyenno-meditsinskiy zhurnal, no. 6, 1964, 53-54.

A case history of a pilot who experienced acute decompression is provided. Decompression occurred at 11,000 m when the cabin depressurized suddenly. A total 30 min was spent in this condition. At first, the pilot felt itching sensations on the upper half of his trunk followed by a weakening of his hands. The aircraft was taken down to an altitude of 7,000 m. At this time, nausea and complete manual disability occurred. The pilot had extreme difficulty reading his instruments. Upon landing, his vision improved somewhat, but nausea recurred and he quickly lost consciousness.

The subject arrived at the infirmary in a comatose state. Diffuse edema was evident on the torso. The pulse was rhythmic but weak (80 beats/min). Arterial pressure was 90/70 and the heart was enlarged by 1 cm on its left side. Respiration was 20/min and generally weak. The tongue was white and coated. Pupillary reaction to light was weakened. Reflexes were generally weakened and hypotonia was evident.

EKG indices were as follows: PQ-0.14 sec; QRS-0.1 sec; QRST-0.34 sec. The condition of the subject remained acute for several hours. Pulse was weak (100 beats/min) and arterial pressure was 80/20.

Therapeutic measures included an oxygen mask, a 1 ml, 0.06% intravenous injection of corglycon in a 10 ml 40% glucose solution, 1 ml 1% intramuscular injection of mezaton, and 200 ml of polyglucin using an IV drip setup. Later, polyglucin was curtailed because of vomiting.

After nine hours, the condition of the subject improved. Cutaneous edema disappeared, pulse improved, arterial pressure increased (100/90), and coma depth decreased. Reflex and pupillary reactions were also

improved. At this time, treatment consisted of a 10 ml 2.4% IV injection of aminophylline in a 10 ml 40% glucose solution and a 10 ml 25% intramuscular injection of magnesium sulfate and bromides.

After three days, the condition of the patient was drastically improved. Further therapy consisted of a 0.05% solution of prostigmin given in 1 ml subcutaneous injections and 0.005 G of dibasol per day.

Other symptoms noted were erythrocytosis and urinary hyperglycemia apparently due to CNS disruption. The authors stated that despite the severity of decompression symptoms, the therapeutic measures taken had a good effect.

COMMENT: Only this individual case was discussed. The authors did not present a statistical survey on the effectiveness of their therapy on other cases nor were any other cases mentioned. No bibliography. [CD]

5. Decompression Sickness at Small Depths (11--13 m)

SOURCE: Klintsevich, G. N. Voyenno-meditsinskiy zhurnal, no. 9, 1964, 62--64.

The assumption that decompression sickness only occurs after dives of 12.5 m or deeper is challenged by a case history. In Nov-Dec, 1962, divers were engaged in exhausting work at depths of 11--13 m in the Kola Gulf. During one 3--7 hr dive, the divers (equipped with ventilated pressure suits) complained of fatigue, shortness of breath, excess perspiration, and headache. On completion of the work, three divers developed decompression sickness and were placed, still in their wet suit liners, in a decompression chamber at 3 atm for 3 hr. When symptoms remained, divers stayed 5--7 hr in the chamber at 0.9 atm. At this point they complained of sharp pains in bones and joints, weakness, dizziness, nausea, i.e. decompression sickness had become more severe. Analysis of this case history shows that several factors contributed to the onset and intensification of decompression sickness. First, the divers were already fatigued from several days of heavy work under water, and the increased CO_2 levels in their blood promoted saturation of body tissues with nitrogen. Secondly,

divers were excessively cooled during decompression, inhibiting recovery processes. During the incorrectly applied decompression regimen, gas bubbles spread to other organs and exacerbated the decompression sickness. This case history confirms reported cases of decompression sickness after repeated shallow dives: gas bubbles remaining in the blood unnoticed after decompression predispose the diver to decompression sickness upon repeated diving. [JS]

6. Medical Protection of Deep Sea Divers

SOURCE: Nikitin, V. F. (Captain of medical service) Morskoy sbornik, no. 9, 1965, 75-78.

The effects of different gas mixtures and methods of recompression on deep-sea divers (60 m and more) were studied. In the opinion of the authors, the helium-air mixture was more desirable than helium-oxygen because it cooled the organism and altered voice pitch less. Pure air was unsatisfactory because of its nitrogen composition, which had a narcotic effect. Of the 109 divers, 56 percent were not susceptible to decompression sickness, 28 percent were moderately susceptible, and 16 percent were quite susceptible. No symptoms in the first group were observed during surfacing and decompression; the second group showed symptoms under these conditions; the third group showed symptoms during a prolonged decompression regime. This classification of divers facilitated the implementation of decompression programs which modified individual physiological peculiarities. It was found that divers were more susceptible to decompression illness at night and during the winter. Also, susceptibility to decompression disorders increased with age, which necessitated special decompression regimes for the older divers (prolonged decompression time). Exposure to depths greater than 45 m increased the incidence of decompression disorders. These could be precluded by means of prolonged decompression residences. The air temperature of the well-ventilated decompression chamber was 17--22C. While in the chamber, divers exercised and massaged their extremities. Oxygen decompression tended to lower the incidence of illness, and ventilation of respiratory passages took place every 5--7 min. As a result of exercise, the illness incidence was 0.8 percent while at rest, the incidence reached 3.8 percent. To prevent acute forms of decompression

illness, divers were not allowed to sleep for 2--3 hr after being subjected to great depths. Thereafter, (4--8 hr) they were awakened on the hour. By means of these methods, the incidence of decompression sickness using a helium-oxygen mixture was decreased from 4.9 percent in 1960 to 1.0 percent in 1964, while the incidence using air decreased from 1.0 percent in 1960 to 1.0 percent in 1964, while the incidence using air decreased from 1.0 percent to zero in the same period. It was established that in the majority of cases, the causes of decompression symptoms were heavy physical strain at sea level and disruption of the sequence of the descent and surfacing processes and decompression in the chamber. In some cases, the wrong system of decompression was selected for individuals. Specific symptoms observed during descents using ventilation and helium-oxygen supply systems were CO_2 poisoning, eardrum pressure, and nitrogen narcosis. CO_2 poisoning took place in two divers and appeared to be the result of heavy physical strain at sea level and poor suit ventilation. Eardrum pressure took place in the decompression chamber as some divers transferred from one section to another, lowering pressure by 4 m. It was successfully treated. Nitrogen narcosis took place at depths of 60--65 m and was attributed to poor diver training. [CD]

7. An EEG Study of Caisson Disease

SOURCE: Rozsahegyi, I. Ceskoslovenska neurologie, no. 6, 1966, 386-390 (in Czech.)

A total of 107 personnel who worked in diving bells were given EEG examinations. The following conclusions were drawn: 1) In workers not yet affected by caisson disease, the incidence of EEG abnormalities was slightly higher than normal; 2) in workers affected by decompression and exhibiting osteoarthritic symptoms, the incidence of EEG abnormalities was higher than in the group above; 3) in workers with a pure labyrinthine form of decompression sickness, the incidence of EEG abnormalities comprised 50% of the group; 4) in workers exhibiting the central nervous system form of decompression sickness, the incidence of EEG abnormalities comprised 66.7% of the group. Most EEG's taken from this

group indicated that the medulla oblongata and diencephalon were affected. When decompression sickness affected the spine and rhombencephalon, EEG's indicated injury to higher sections of the central nervous system. EEG changes attributable to decompression injury improve in the course of years. However, only in very exceptional cases does complete EEG normalization take place. [CD]

8. The Neurological Form of Caisson Disease

SOURCE: Ceskoslovenska neurologie, no. 6, 1966, 391-395 (in Czech.)

On the basis of his own observations, the author discusses the central nervous system symptoms of decompression sickness. Four forms of central nervous system affectation are observed: 1) Disperse focal lesions of the central nervous system; 2) multiple lesions of the cerebral hemispheres and upper medulla oblongata; 3) injury to the thombencephalon; 4) injury to the spinal cord. The acute, primary as well as the chronic, secondary forms of the disease are considered. The author stresses the incidence of autonomic and mental changes caused by decompression sickness as well as the variability of the clinical aspects of this sickness. [CD]

9. Pressure Injury to the Inner Ear as a Result of Diving

SOURCE: Voyenno-meditsinskiy zhurnal, no. 7, 1964, 68-69.

Two cases histories of inner ear injuries suffered by divers are presented. Clinical details of the symptoms are given. One injury occurred in a recompression chamber at 2 atm while the other took place after a dive to a depth of 15 m. The condition of both divers improved after two weeks and ultimate recovery occurred after three weeks with no further complications.

The mechanism of inner ear injury is said to be the result of two phenomena. The first involves the disrupted conductivity of eustachian tubes. During increased atmospheric pressure, negative pressure against the ear drum takes place as a result of an inner ear-outer ear pressure differential. The pressure against the ear drum cannot compensate this pressure differential which means that the ear drum creates a partial vacuum. Blood vessels of the middle ear dilate, some hemorrhaging in the tympanic cavity occurs and occasionally, rupture of the ear drum.

The second cause of pressure injury to the labyrinth is rapid decompression during which elevated amounts of nitrogen in tissues and fluids are not released by the blood through the lungs. Here, gas bubbles circulating in the blood in the form of embolisms can block certain vessels, those of the labyrinth in particular. This leads to increased intralabyrinthine pressure and subsequent irritation of the peripheral receptor of the vestibular analyzer. However, injury to the labyrinth is possible only at a pressure of 2.5 atm (or 15 m underwater) for a duration of 105 min with decompression occurring in less than two minutes. Under these conditions, gas bubbles can form in the blood during decompression.

Both mechanisms of injury to the labyrinth due to pressure suggest that hemorrhaging blood or air bubbles formed in the inner ear act on the neuroepithelium of the vestibular analyzer causing its initial excitation and subsequent inhibition. Depending on the severity of these two factors, full or partial restoration of the labyrinth occurs.

Apparently, the two cases observed by the authors were attributable to disrupted pressure function of the middle ear which caused hemorrhaging in both the inner ear cavity and labyrinth. The small depth of the dives (10--15 m) and the short duration of stay under pressure (5 min) coupled with an average submergence time of 15 minutes argues against a caisson mechanism of injury to the labyrinth in these two cases. [CD]

Section V. Problems of Respiration Under Hyperoxic Conditions

1. The Effect of Oxygen Inhalation at Normal and Increased Pressure on Human Hemodynamics and Electrocardiograms

SOURCE: Sorokin, P. A. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), vol. 2, Moscow-Leningrad, Izd-vo "Nauka", 1958. 46-60.

Studies of blood circulation under conditions of high oxygen pressures (such as those encountered in diving and caisson work) are described. In the first series of tests, five healthy young subjects breathed 96--98% oxygen at absolute pressures of 1.2--2.3 atm for 5 hr. Subjects were tested while reclining in a pressure chamber. In the second test series, four healthy divers aged 20--21 were tested while sitting in the chamber 3--3.5 hr after meals. The divers breathed oxygen at an absolute pressure of 1 or 2 atm for 2 hr. Lobeline hydrochloride was injected in doses of approximately 0.03--0.05 mg/kg to measure the circulation rate. Cardiac blood output was determined by multiplying the stroke volume by the number of systoles per min.

In the first series of tests, with oxygen pressures of 2 and 2.3 atm, subjects complained of weakness, fatigue, increased perspiration, etc. In the second test series, exposures to oxygen were shorter, and the general condition of subjects didn't change.

In contradiction to literature data on the high incidence of tracheobronchitis from prolonged oxygen inhalation at normal pressure, no symptoms of tracheobronchitis were found in these subjects. One subject, who inhaled O_2 at pressures of 1.2--2.3 atm 2--5 hr for 33 days, also showed no symptoms of bronchitis. Clearly defined changes in blood circulation were detected among subjects inhaling oxygen at normal and increased pressures. Tests showed a decrease in the number of systoles (an average of 17.7%) after oxygen inhalation at absolute pressures of 1.0, 2.0, and 2.3 atm. It was stated that administration of lobeline did not substantially affect the slowing down of cardiac activity during oxygen inhalation. Diastolic pressure increased in half of the subjects (by 5 to 30 mm Hg) and systolic pressure rose in 18 out of 50 cases. In the first test series, individual peculiarities in the reaction of the blood pressure to oxygen inhalation at both normal and increased

pressure were observed. Blood pressure (especially diastolic pressure) tended to return to normal 30--40 min after decompression and the switch to breathing air. In the second test series, the absence of a reaction of the systolic blood pressure to high oxygen pressures is apparently due to the shorter exposure times.

The blood circulation rate slowed down in a number of cases. At the end of 2 hr of breathing O_2 at pressures of 1 and 2 atm, circulation was slowed significantly in 3 out of 18 cases, and less drastically in 8 other cases.

Cardiac output decreased by 24.2% on the average: decreased cardiac output was a constant phenomenon in tests at both normal and increased pressure. Changes in the electrocardiogram at absolute oxygen pressures of 1, 2, and 2.3 atm. occurred as follows: cardiac activity slowed down and there was a frequent transition from normal rhythm to sinus bradycardia; the height of the P-wave was reduced; and irregular increases occurred in R- and T- waves. The most common symptom, however, was still decrease in the number of systoles. It is interesting to note that even slight exercise was usually sufficient to normalize the P-wave while inhaling O_2 at increased pressure.

Experimental results showed that a decrease in the number of systoles is the most common reaction of the cardiovascular system to breathing O_2 at absolute pressures of 1.0, 2.0 and 2.3 atm. Possible mechanisms of changes in circulation occurring during inhalation of oxygen at increased pressure are discussed, and theories are compared with hypotheses in the literature. The described changes in circulation are temporary and consist of adaptive reactions to high partial oxygen pressure.

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Brandgendler, V. S. Coll. "Vasomotornyye svoystva krovi" (Vasomotor properties of the blood), Moscow, 1927.

Brestkin, A. P. Opyt eksperimental'nogo i teoreticheskogo issledovaniy etiologii i profilaktiki kessonnoy bolezni (Experience in experimental and theoretical investigations of the etiology and prophylaxis of caisson disease), Diss., Leningrad, 1953. [JS]

2. Review on the Biological Effects of Increased Oxygen Partial Pressure

SOURCE: Govorov, A. I. and A. F. Panin. Voyenno-meditsinskiy zhurnal, no. 2, 1966, 26-30.

The author reviews the Soviet literature dating back to 1958 and opens his paper with the statement that O_2 respiration at pressures of 1 atm or higher is widely accepted in diving practice. This regime is used to abbreviate decompression time when divers are recovering from increased air pressure conditions and to treat decompression sickness. The measure is based on the fact that the respiration of pure O_2 sharply decreases the partial pressure of inert gases (nitrogen, helium and other unspecified gases, hydrogen not mentioned) in alveolar air which induces the optimum diffusion of these gases from the blood.

One of the most important problems in this area involves the establishment of limits for the safe human respiration of oxygen under increased pressures. Research to this end has been conducted in the Kirov Military Medical Academy. Names cited in this research effort include A. V. Voyno-Yasenetskiy, A. I. Govorov, P. M. Gramenitskiy, A. G. Zhironkin, A. F. Panin, P. A. Sorokin and others all under the direction of L. A. Orbeli, M. P. Brestkin, and G. E. Vladimirov. On the basis of this research, the following table was composed.

Table 1. Safe limits for human respiration under increased O_2 partial pressure.

O_2 pressure		Duration of safe respiration
AT.	mm Hg	
0.45	342	up to 7 days
0.70	533	up to 6 days
1.0	760	up to 1 day
2.0	1520	up to 3 hr
3.0	2280	up to 2 hr

The authors go on to discuss the possible mechanisms of effect of increased O_2 partial pressures on the organism and the application of this factor in clinical medicine. [CD]

3. Effects of Compensating External Pressure During Respiration at an Excess Intrapulmonary Pressure

SOURCE: Safonov, V. A. Patologicheskaya fiziologiya i eksperimental'naya terapiya, v. 10, no. 6, 1966, 85-88.

In this review of the literature, the author discusses the effects of abdominal and extremity pressure support on respiration under conditions of excess intrapulmonary pressure. Most attention is paid to the favorable effects of abdominal support under these conditions although extremity support is not overlooked since such support normalizes circulation which in turn eliminates reflex effects on respiratory regulation (via afferent stimuli from circulatory receptors). The author concluded that counterpressure on the surface of the body has a overall favorable effect on the neuroreflectory regulation of the respiratory center at high intrapulmonary pressures. [CD]

4. Effect of Hyperoxia on Gas Metabolism

SOURCE: Troshikhin, G. V. Byulleten' eksperimental'noy biologii i meditsiny, v. 62, no. 12, 1966. 46-49.

The purpose of this study was to study the dynamics of gas metabolism during a prolonged stay of animals in a medium with an increased concentration of oxygen. A total of 76 white mice of the CC 57W strain were placed in 2 hermetic chambers. One chamber contained a hyperoxic mixture; the other contained air (control). The chambers were connected to a closed air regeneration system; oxygen was released automatically by a gas meter in proportion to the animals' oxygen consumption. The temperature was maintained at 20--23°. The gas metabolism of the animals was determined in mediums with the following

oxygen content: I. 40% O_2 for 27 days; II. 60% O_2 for 39 days; III. 80% O_2 for 42 days; IV. 90% O_2 for 10 days.

In the first series of experiments, animals showed a short period of increased O_2 consumption (3 days) followed by a return to normal. In the second series, there was a longer period of increased O_2 consumption (26 days) and then a gradual return to the normal level. The higher amount of O_2 consumption in both series of experiments was accompanied by an increased CO_2 release. There were no observed differences in weight between the control and experimental mice as a result of the tests. The third series caused a decrease in gas metabolism during the entire experiment with an especially sharp decrease (27%) noticed on the 8--9th days. The weight of the animals dropped by 20% after the end of the experiments; O_2 consumption did not return to normal for 8 days after the experiments even though weight had returned to normal. In the fourth series, there was a marked drop of gas metabolism from the 1st day, and by the 4th day it had decreased by 60% of original amount. On the 7th day mice began to die. In the majority of deaths, inflammation occurred. In 3 survivors, consumption of oxygen increased with resumed respiration of air and reached normal on the 9th day. Thus, in animals exposed to an 80% medium there was no mortality, however, sluggishness, adynamia and decreased appetite were observed. A 90% concentration of O_2 was clearly toxic. Changes in gas metabolism in mice after a prolonged stay in hyperoxic conditions with various percentile contents of oxygen reflect, most probably, complex physiological changes in metabolic processes of the body. [SC]

5. The Belau Spirometer

SOURCE: Vinogradskiy, O. V. and P. O. Vyazitskiy. Voyenno-meditsinskiy zhurnal, no. 8, 1964, 60-63.

The Belau spirometer is an open system in that the subject breathes atmospheric air. The following indices can be measured through the use of this device: frequency and depth of breathing; per minute respiratory volume; O_2 absorption; CO_2 output in cm^3/min, and a

number of derived values such as respiratory coefficient and O_2 consumption coefficient.

Two new values were proposed which could also be obtained using the Belau spirometer. These are the "recovery coefficient" and "half periods of adaptation and recovery". Original research by the authors revealed that the Belau apparatus is more accurate than other systems such as the Kniping apparatus. The former has been tested on various healthy subjects using a rest-work-rest regimen lasting 15 min. Figure 1 shows a typical respiratory diagram. Section "a" between the

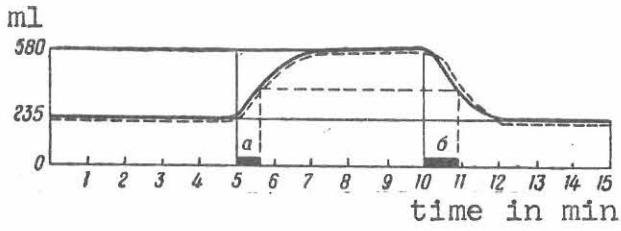

Fig. 1. Typical Belau Respiratory Diagram

——— O_2 consumption; ----- CO_2 output.

5th and 6th minutes represents the "half period of adaptation and recovery", e.g. the time required for O_2 consumption to attain half its maximum level. Period "б" represents the time required for O_2 consumption to decrease by half. Period "a" reflects the rate of development of adaptive reactions to work while period "b" reflects the time required to recover from elevated O_2 requirement.

The method outlined by the authors is proposed for use in sports medicine to reveal the level of athlete training. It has already been used in military practice. Among the many profiles studied were divers with two or more years of experience. The Belau spirometer can be used to determine the respiratory characteristics of various types of activities and will likely find wide application in clinical sports, and military medical practice. (No bibliography provided). [CD]

6. New Spirograph

SOURCE: Meditsinskaya gazeta, 13 Dec 1966, p. 4, col. 4

The All-Union Scientific Research Institute of Medical Instrumentation together with the Kiyev Medical Instrumentation Factory has designed the "Spiro 2-25D." It is used to study respiration during normal and pathological conditions. The device permits determination of the respiratory and reserve volume of the lungs, respiratory rate, minute and maximum ventilation. Respiration during rest or exercise can be studied. Air in its system is constantly renewed which permits chronic observations. The spirograph is portable, light weight, equipped with a mask and intake and exhaust hoses, and there is no danger of mass infection (no figures provided.) [CD]

7. The Use of the DP-2 Device for Pressure Therapy

SOURCE: Voyenno-meditsinskiy zhurnal, no. 11, 1966, 79-80.

Pressure therapy, used primarily for disorders associated with diving, is now proposed for various clinical uses. Fig. 1 shows the basic design of the DP-2, a portable apparatus used for pressure therapy.

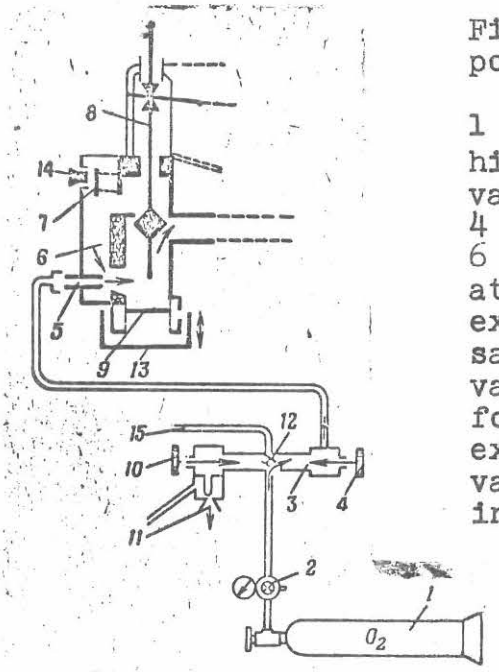

Fig. 1. Basic diagram of the portable DP-2 apparatus

1 - O_2 tank; 2 - reducer with high pressure manometer and safety valve; 3 - O_2 feed regulator; 4 - regulator valve; 5 - injector; 6 - chamber; 7 - valve preventing atmospheric leakage; 8 - inhale-exhale regulator valve; 9 - safety valve; 10 - aspiration valve; 11 - ejector; 12 - sleeve for hose attachment; 13 - inhale-exhale regulator nut; 14 - leak valve stopper; 15 - hose carrying the gas mixture.

An 18-20% helium-oxygen mixture is recommended by the authors as a therapeutic respiratory medium. A pressure of up to 10 atm can be effectively applied. When necessary, the DP-2 can be used as an oxygen inhaler by closing the atmospheric air inlet and hooking up the O_2 tank. Such therapy facilitates reflex stimulation of the respiratory center. Its use is indicated for respiratory center paralyses caused by embolisms (decompression sickness, pulmonary pressure injury, post-surgical aeroembolism etc.) and acute hypoxia. Few alterations in the instrumentation of the DP-2 are necessary for clinical practice. (No bibliography). [CD]

Section VI. Problems of Hypoxia

1. Effect of Reduced Partial Oxygen Pressure on the Organism and Compensatory Mechanisms

SOURCE: Brestkin, A. P. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 3-11.

Research on the effects of hypoxemia on the organism is reviewed, and previously unsolved questions about the precise mechanisms of the hypoxemia effect are considered. First the relative importance of oxygen tension and oxygen content in the blood as factors causing functional shifts and disorders is evaluated. Experimental observations by the author and others show that decreased oxygen tension in blood plasma is more destructive to bodily functions than a decreased amount of oxygen in the blood. Prof. I. P. Petrov, for example, demonstrated that animals subjected to low pressures after considerable bleeding kept their previous altitude resistance, and Prof. P. I. Yegorov found no difference in tolerance of low pressures among human subjects with different amounts of hemoglobin. E. I. Atakhanov, G. Ye. Vladimirov and L. L. Shik presented supporting evidence.

A. F. Kulev has also done important work in this area. He demonstrated that animals kept 6 hr at a pressure chamber altitude of 8000 m had the same amount of oxygen in their blood as a group of animals bled two days before. However, only the pressure-chamber animals showed respiratory shifts, disruptions in CNS function, and hypocapnia. These experiments are evidence that the drop in blood oxygen tension rather than the decrease in total oxygen content is responsible for functional changes in the organism in response to low atmospheric pO_2.

S. I. Vinogradov, P. M. Gramenitskiy, and P. V. Oblapenko (colleagues of Brestkin) conducted pressure-chamber experiments with animals partially transfused with blood substitutes or intact. These animals remained alive for minutes or hours with 3--4% O_2 in arterial blood and suffered no respiratory or circulatory disruptions if the oxygen tension in the plasma was not reduced.

The above studies show the need to distinguish between hypoxemia caused by a drop in atmospheric partial oxygen pressure and hypoxemia caused by decreased hemoglobin in the blood. Oxygen tension in the plasma stimulates receptor formations in the vascular parietes and

helps to determine the volume of oxygen transferred to the organs. More research is needed to discover if these factors adequately explain the importance of blood oxygen tension.

Bodily mechanisms for regulating oxygen tension in the blood in response to adverse environmental conditions are considered next. In order to counteract the effects of hypoxemia, the human body responds by stepping up pulmonary ventilation. Increased pulmonary ventilation, however, produces both a reduction in pCO_2 and an increase in pO_2. Mosso first suggested that hypocapnia (low carbon dioxide tension) is a principal cause of functional disorders at high altitudes. V. A. Skrypin and A. G. Zhironkin later showed that addition of 6--7% CO_2 to the respiratory mixture improves resistance to hypoxemia in people subjected to simulated altitudes of 6000--7000 m. Furthermore, adding carbon dioxide to the respiratory mixture doesn't produce very great changes in oxygen tension.

V. N. Zvorykin observed the beneficial effect of 1.2--10% CO_2 on functional disorders of the nervous system in dogs at simulated altitudes of 6000--8000 m. The beneficial effects of CO_2 on excitation--inhibition processes, conditioned reflex activity, etc., varied with individual dogs and with different experimental conditions. L. I. Mkrtycheva and V. G. Samsonova further showed that CO_2 can normalize color vision disorders occurring at 5000 m.

O. Yu. Sidorov used optical chronaxy to study optical analyzer function in people subjected to pressure conditions equivalent to 5000 m. Subjects breathing 3.5--4% CO_2 in the pressure-chamber atmosphere showed 41% deviation in light perception after 30 min, as compared with a 238% deviation in control subjects breathing standard atmospheric air. At the same time, measurements with an oxyhemometer showed 2.3% less oxyhemoglobin in the blood of experimental subjects. Analysis of alveolar air at 5000 m revealed the following: for control subjects, oxygen pressure of 44 mm Hg., and carbon dioxide pressure of 25.7 mm Hg.; and for subjects breathing 3.5--4% CO_2, oxygen pressure of 47.2 mm Hg. and carbon dioxide pressure of 31.5 mm Hg.

The research discussed above points to hypocapnia as the principal cause of severe functional disorders during hypoxemia. In other words, hypoxemia seems to affect the organism indirectly through hypocapnia. It is interesting that hypocapnia, which by this evidence is detrimental to the organism, is the result of the body's adaptive reaction to compensate for hypoxemia by hyperventilation. While increasing oxygen tension in the blood slightly, hyperventilation washes out carbon dioxide, producing serious functional disorders. Only at very high altitudes does addition of CO_2 to the respiratory mixture seem inadvisable, as it diminishes somewhat the already low pO_2 . However, P. M. Gramenitskiy, Z. K. Sulimo-Samuyllo and A. G. Tripolov observed that normalizing the carbon dioxide tension at 15,000--16,000 m restored functions to surviving animals more rapidly and completely.

In conclusion, it should be noted that low atmospheric pO_2 is an extraordinary environmental factor, for which the organism is unprepared by its evolutionary development. Much more study of phenomena associated with hypoxemia is needed to complete the picture. [JS]

2. Effect of Small Doses of Parenteral Strychnine and Saline on the Course of Hyperoxemic Convulsions in Mice

SOURCE: Dvorzhak, I. I. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958, 61-65.

Earlier studies have shown that both the direct effects of excess oxygen tension on the CNS and reflex processes in the CNS have a part in the evelopment of hyperoxemic spasms. The present study sought to determine whether a subspasmogenic dose (0.1 ml) of 0.01% strychnine injected before exposure to hyperoxia would help the organism resist hyperoxic spasms (by increasing CNS excitability and oxygen requirement), or would reduce resistance to hyperoxic spasms (synergically, since strychnine is itself a spasmogen). White mice weighing 15--25 g were used. The controls (55 mice) received the subspasmogenic dose of strychnine without exposure to hyperoxia. The experimental animals were divided into 3 groups: the 1st group (72 mice) received 0.1 ml of 0.01% strychnine; the 2d group (72 mice) an equal amount of physiological saline; and the third group (71 mice) received neither strychnine nor saline injections. All 3 groups were exposed to compressed oxygen in a chamber (5±0.5 atm for 15 or 20 min). General condition of the animals, time to onset of spasms, and time of death were observed in all the experimental animals, and rectal temps were obtained for 90 mice from all groups at the beginning and end of the experiment. Intact mice (no injections) exhibited spasms after 7 to 8 min of hyperoxia. The seizures began with masticatory movements, quickly developing into generalized clonic and tonic spasms, involving the entire body. Seizures lasted several dozen seconds and recurred at 1 to 5 min intervals. Normal posture and motor activity was observed between spasms. Prior injection with strychnine or saline did not change this general pattern of reaction.. Onset of seisures was later (8 to 10 min) in some of the strychninized mice; in others it was earlier, with death following rapidly. Of 13 intact mice exposed to high pressure O_2 for 15 min, 2 died; of 15 strychninized mice, 5 died; and of 13 saline-injected mice, 2 died. Changes

in O_2 pressure during oxygen intoxication tended to provoke spasms in animals from all 3 groups, especially the strychninized group. With longer exposure to hyperoxia (20 min), a new phase, called the exhaustion phase, appeared, with the animals lying motionless, gaping, and labored or periodic respiration. The longer exposure produced a higher mortality in all groups, and revealed considerable differences between the 3 groups: of 58 intact mice, 21 died (36.2%); of 49 salinized mice, 37 died (75.5%); of 57 strychninized mice, 52 died (91.2). Death occurred 20 to 41 min after decompression. Strychninized mice showed an earlier (1 to 2 min) onset of spasms, more frequent seizures, and increased susceptibility to spasmogenic stimuli (pressure changes, handling). Hypothermia (rectal temperatures 3 to 5 or 7° below normal 10 to 15 min after decompression) was seen in all the oxygen intoxicated mice. This drop was greatest in the strychninized, least in the intact animals. Strychnine alone (without hyperoxia) also caused a slight temperature drop, not over 1°C. It is concluded that subspasmogenic doses of strychnine act on the CNS to decrease ability of mice to survive hyperoxemia. The afferent impulsation caused by injection itself (salinized group) has a perceptible, but much slighter, adverse effect. [DP]

3. Functional and Morphological CNS Changes in a Rarefied Atmosphere Equivalent to 18000 m

SOURCE: Vinokurov, B. A., A. E. Gevorkov, V. P. Kurkovskiy, and I. D. Kharchenko. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium). v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 66-80.

Little information is available on the forms and degrees of oxygen starvation encountered at high altitudes, and no unanimity of opinion on the role of carbon dioxide. The authors therefore wished to examine the patterns of disruption, and the restoration of fundamental CNS functions in animals after a 2-minute stay at an altitude of 18000 m, both without the use of CO_2 and with the preliminary inhalation of a gaseous mixture containing CO_2; and to study the effect of repeated ascents to an altitude of 18000 m on the course of acute oxygen starvation and subsequent restoration of the fundamental CNS functions.

Cats were elevated to an "altitude" of 18000 m in a pressure chamber. Time of ascent averaged 13 to 15 sec, and time of descent 15 to 17 sec. The animals were kept at 18000 m for 2 minutes. Three series of tests were made. In the 1st series, the cats were exposed to a single 2-min elevation to an "altitude" of 18000 m. In the 2d series, the cats breathed hypercapnic (8%--10% CO_2) air for 15 min before ascent. In the 3d series, the effect of repeated "ascents" to 18000 m was studied. Most of the animals which succumbed were autopsied. In some cases, the brain, spinal cord with intervertebral ganglions, and lungs were histologically examined. A total of 153 tests were made on 40 cats.

It was found that restoration of CNS functions disrupted by barochamber elevation to 18000 m occurs in the following order: 1) afterbrain reflex activity, 2) midbrain function, 3) subcortical node function, and 4) cerebellar and cerebral function. Inhalation of hypercapnic mixtures somewhat increases CNS tolerance of oxygen starvation, particularly that of the respiratory center. The beneficial effects of CO_2 inhalation are clearest during the restoration period. The 2d test series shows disordered CNS functions to be more rapidly restored when CO_2 inhalation precedes barochamber flight. It is assumed that hypercapnia changes metabolic processes in nervous tissue and increases the resistance of nerve

cells to oxygen starvation. This agrees with data from the literature.

Cortical blindness occurred in 4 animals, following both single and repeated ascents. In one case, blindness occurred after the 3d ascent and persisted for 18 days (until the animal was killed); in the other cases, cortical blindness was temporary, vision being restored on the following day. Histologic analysis was necessary to establish the mechanism of these functional effects. The permamently blinded cat showed extensive nerve cell destruction in the cortex of the occipital lobes, and in elements of the sincipital and frontal lobes. Cell destruction was accompanied by violent inflammatory-infiltrative changes in both parenchyma and membranes. Permanent blindness was thus due to previously acquired but unrecognized encephalomeningitis which was aggravated by acute oxygen deficiency to destroy a large number of nerve cells in the visual analyser and other regions causing permanent blindness. In the second animal, with temporary blindness, microhistological study showed only slight and reversible changes in nerve elements in the cortex of the occipital lobes and adjacent regions, and no inflammation. Permanent cortical blindness was therefore considered an accident without essential significance in the given test series.

Histological observations on the spinal ganglia were also of interest. These ganglia showed rather sharp alterations, especially in the cat with encephalomeningitis. Necrobiotic nerve cells, often unusual in appearance, were frequently seen (especially in cervical and lumbar ganglia). These changes would doubtless have resulted in substantial disorders in the ganglia structure and associated sensory terminals, so that changes in the latter due to oxygen deficiency are largely of secondary importance.

Thoracotomy was performed in most of the animals and almost always revealed macroscopic changes in the lungs. These usually consisted of extensive coalescing hemorrhages or numerous focal effusions of blood. The lungs of 2 cats were examined microscopically: the lungs of a cat which died in the 12th ascent showed atelectasis and multiple diffuse extravasations into pulmonary tissue; the lungs of a cat killed after com-

plete restoration following the 12th ascent, nevertheless still showed hemorrhages in the alveolar cavities of individual pulmonary sections. The latter finding shows that repeated exposure to a highly rarefied atmosphere may cause pathological changes in pulmonary tissue even though the animal seems to be in good condition.

The existence of adaptation to extreme degrees of oxygen deficiency is especially noteworthy. Although the mechanism of these adaptation phenomena is not yet clear, it is certain that the enhancement of O_2 acquisition processes play no part, since at 18000 m it is not possible to draw O_2 from the ambient air. There must therefore be a certain readjustment of metabolic processes reducing the oxygen requirement of the organism. Possibly these adaptation phenomena result from protective inhibition in the cerebral cortex and other sections of the CNS, which to some defree protects the nerve cells from O_2 starvation death, thus facilitating the subsequent restoration of normal function. The nature of this adaptation should receive special study. It should be emphasized that adaptation takes place even when substantial morphological changes occur in certain organs, and even when the noxious factor becomes lethal.

To recapitulate: 1) For cats, 2 min at 18000 m is the maximum permissible exposure (mortality was 11 cats out of 40 in the first ascent). 2) Preliminary inhalation of hypercapnic air (8%--10% CO_2) somewhat prolonged the period of suspended vital function and shortened the period of restoration of vital functions. 3) Repeated exposure markedly delay the occurrence of critical disorders and shorten the time of functional CNS restoration. [DP]

4. Effect of Efferent Nerves on Cardiac Activity in Asphyxia and Hypoxemia

SOURCE: Vinokurov, B. A. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 81-91.

In most studies the variations in cardiac activity characteristic of oxygen deficiency are assumed to result from excitation of cardiovascular centers. The problem of variations in cardiac reactivity relative to neural influences during oxygen deficiency has not been sufficiently studied.

In this study, dogs anesthetized with an ether chloroform mixture were surgically prepared by tracheotomy, crushing the spinal cord below the medulla oblongata, open thoracotomy, resection of the cervical muscles, and isolation of the branches of the cardiac plexus. After the spinal cord was pinched off artificial respiration was started. Throughout the experiment, the heart was moistened with warm Tyrode's solution every 3 to 5 minutes and the animal was kept warm with the aid of a heat lamp and heating pads. Systoles were recorded by a cardiac catheter introduced through the left jugular vein into the right ventricle. After being introduced into the right ventricle, the catheter was connected to a Marey's capsule and slightly inflated. This system can register even insignificant variations in the heart's activity, though it does not permit measurement of systolic force in absolute terms. The cardiac branches were stimulated with an induction current. Both the vagus nerve and the subclavian ansae were cut just before starting the stimulation. Stimulation of the cardiac branches was conducted both during hypoxemia (33 dogs) and during asphyxia (19 dogs). Hypoxemia was produced by using a gas mixture of nitrogen with 4% oxygen or 2.7 oxygen. Asphyxia was produced by suspending artificial respiration.

The results of the study indicate that in asphyxia and hypoxemia, cardiac activity is strongly affected by neural influences. The distinguishing feature of cardiovascular reactions to asphyxia and severe hypoxemia is a sharp drop in heart rate which enhances cardiac tolerance of acute oxygen deficiency. The current study shows that

varying reactivity of the heart itself is largely responsible for this reaction. There is not sufficient data on which to base any conclusions as to the intimate mechanism of variations in cardiac activity in acute oxygen deficiency. However, it is certain that this mechanism is to be sought among disorders and variations of metabolic processes in the myocardium. This is particularly important in studying the effect of the reinforcing nerve. In the present study, the degree of hypoxemia and asphyxia was so severe and the blood contained so little oxygen that impulses transmitted along the reinforcing nerves failed to improve the "vital properties" of the myocardium by normalizing its metabolic processes.

To recapitulate: 1. Cardiac reactivity to nervous stimulation changes sharply in asphyxia and acute hypoxemia: cardiac sensitivity to inhibitory influences increases at the same time that cardiac sensitivity to stimulating influences decreases. 2. During extremely severe hypoxemia, neural or humoral stimulation of cardiac activity may induce flutter. [DP]

5. The Significance of Afferentation from Various Receptors during Hypoxemia

SOURCE: Zagryadskiy, V. P. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenov. Funktsii organizma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), vol. 2, Moscow-Leningrad, Izd-vo AN SSSR 1958. 92-101.

There have been few studies directly pertaining to the mechanism of spasms caused by hypoxemia. Moreover, the significance of reflexes from receptor organs during hypoxemia induced spasms has not been clarified.

To investigate this problem, three series of tests involving 18 dogs and 10 cats were conducted (170 tests in all). Hypoxemia spasms were monitored in a small pressure chamber with 0.37 m^3 capacity. Two glass ports enabled monitoring the behavior and condition of the animals during the experiment. The rate of pressure decrease was kept constant, e.g. 5 km per 5 sec, which ensured a relatively rapid drop in pressure. Pressure recovery took place at a rate of 1 km per 1.2 to 1.3 secs. Recovery was initiated when apnea occurred for a duration of 10--15 secs (dogs) and 30--35 secs (cats). Tests were always conducted during the first half of the day. Animals were fed 16--18 hr prior to each test. The observation of spasms took place at simulated altitudes of 13000 m for dogs and 12000 m for cats. During some of the tests, the spasms were filmed.

In the first series of tests, the role of internal organ reflexes during spasms was studied. Three preoperated dogs with partially eliminated vagus nerves were studied. The operation consisted of transposing the right vagus nerve into a skin flap on the neck. The left vagus nerve was resected.

The second series was designed to study the role of afferent impulses from the proprioceptors during hypoxemia. The posterior columns of the spinal cords of cats were resected.

The purpose of the third series was to clarify the importance of neural impulses from proprioceptors, tactile, and pain receptors during hypoxemia. A novocaine block (2% solution) was used to neutralize afferentation. The solution was injected into the cerebrospinal fluid (0.005 g/kg).

The data indicated that the limitation of afferentation from the GI tract, chemoreceptors of the aorta, lungs and other internal organs through the elimination of vagus influence delayed the onset of spasms caused by hypoxemia and altered their course. Respiratory failure during acute hypoxemia was also delayed by this factor.

The limitation of afferentation from proprioceptors lengthens the latent period of spasms and changes their characteristics. It was therefore concluded that an intensification of afferentation would tend to accelerate the effects of oxygen deficiency on the organism.

This study justified the belief that reflex influences from other receptors (proprioceptors, baroreceptors, algesic receptors, etc.) are as equally important in the development of hypoxemia symptoms as specific chemoreceptor zones of the vascular system. Intensified activity by these structures may contribute to the aggravation of all symptoms of hypoxemia.

The general conclusions of this study were that: 1) afferentation from peripheral receptors have a significant influence on the development of spasmodic states during acute hypoxemia; 2) the restriction of or elimination of influences from internal organs delays the onset of hypoxemia spasms. On the other hand, an intensification of reflex influences from the GI tract promotes the rapid development of this condition; 3) resection of the spinal cord (eliminating proprioceptor influences) also delays the development of hypoxemia spasms; 4) the latent periods of hypoxemia spasms increase substantially when afferent pathways of the spinal cord are blocked by novocaine. [CD]

6. Effect of Protein Consumption on Certain Indices of Gas and Nitrogen Metabolism in Dogs during Severe Hypoxemia

SOURCE: Panin, A. F. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958, 102-110.

There is an absence of studies dealing with the nitrogen metabolism measured in parallel with gas metabolism during the development of acute hypoxemia. The authors studied nitrogen gas metabolism both in the presence and absence of protein consumption during acute hypoxemia. The following indices studied were: gas metabolism volume, residual and amino nitrogen in the blood, nitrogen content of the urine, and quantity of urine.

In the study of nitrogen gas metabolism the volume of pulmonary ventilation with the aid of a water gas meter was measured, the absorption of oxygen and the liberation of carbon dioxide by means of Haldane's apparatus was determined, the respiratory factor was computed, respiratory rhythm was monitored, and the residual nitrogen in 10 ml of protein-free blood filtrate was established. The amino nitrogen in the blood was analyzed by Van Slyke's method with the aid of a manometric model of his apparatus in 5 ml protein-free filtrate obtained in the same way as for the residual nitrogen. The quantity of urine and the nitrogen in it was measured by Kjeldahl's method. In addition, each urine sample was examined for protein content.

The tests were conducted on dogs in which the ureters had been given separate outlets by an operation using the Pavlov-Orbeli method. The dogs were kept on a strict dietary regimen. Special attention was paid to keeping their weight constant. To test the effect of protein intake, the dogs were fed a daily ration of 400 grams of fat-free meat (approximately 20 g per 1 kg of weight).

To determine gas metabolism, the exhaled air was collected at the end of each hour for 10 minutes. A mask provided with inhalation and exhalation valves, sealed along the edges with an airtight gasket, was put over the dogs' muzzles. The mask was connected by means of a corrugated

hose to a Douglas pouch in which the exhaled air was collected. In collecting the samples of exhaled air, double count was kept of the number of respirations per minute. Blood samples (6--8 ml) taken from the jugular vein were gathered in specially adapted test tubes for measuring the residual and amino nitrogen. Blood coagulation was prevented by using a mixture of sodium fluoride and sodium oxalate.

Two test series were conducted: a) to study the gas and nitrogen metabolism in dogs breathing air under conditions of normal pressure; and b) to study the gas and nitrogen metabolism in dogs, in a pressure chamber, breathing air at a pressure of 405 mm Hg, corresponding to an altitude of 5000 m. The duration of the tests ranged from 6--10 hrs. The ascent of the animals in a pressure chamber to 5000 m was carreid out in 5 to 6 min.

Air intake, the determination of the amount of ventilation and the respiration count were conducted in all tests at the end of each hour while the blood and urine samples were collected at the beginning of the first and the second hours, and thereafter every two hours. Protein consumption at 5000 m took place after one hour. Tests at reduced pressure were alternated with control tests, so that the dogs had a period of rest of 4 to 6 days between tests.

It is apparent from tabular data that meat intake induces in the organism a distinct metabolic increase. Thus, the average pulmonary ventilation in liters of air, reduced to 0^{o} and 760 mm Hg, increased after the protein intake by 45 liters in one dog and by 30 liters in another. The per minute absorption of oxygen also increased, viz., by 1.76 liters in one dog and 0.56 liters in another. After the meat consumption the amount of residual nitrogen, amino nitrogen in the blood, nitrogen excreted with urine, and diuresis markedly increased. The amount of amino nitrogen in the blood rose in two dogs by an average of 15--30%, and the amount of nitrogen excreted with urine, 3 to 4 times as compared with the normal rate.

Pulmonary ventilation expressed in liters of air reduced to 0^{o} and 760 mm Hg was somewhat lower (except for the first few hours) at 5000 m altitude than in the control tests and tended to further decrease during the test. The original increase in the pulmonary ventilation (as a rule, during the first and second hour) was evidently attributable to the reaction of the organism to the sharp reduction of the partial oxygen pressure in the inhaled air. It is emphasized that the level of pulmonary ventilation at 5000 m altitude was considerably higher than

in the control tests.

The liberation of the carbon dioxide markedly increased in the early hours at 5000 m; thereafter, (third to the fourth hour) it returned to the normal, and after five to six hours even decreased slightly. The respiration factor also increased within the first few hours at 5000 m. Later, it decreased and remained depressed for the entire duration of the test.

A slight increase in the amount of blood amino nitrogen was noted; the accumulation of this fraction of nitrogen occurs gradually. Owing to the duration of this experiment (8--10 hrs), the amount of nitrogen stabilized.

During the first hour at 5000 m, the amount of urine diminished by 50% in most cases; thereafter, the decrease became less abrupt. However, throughout the altitude tests diuresis remained lower than in the control tests. This decrease in urine excretion, observed by a number of other researchers, is explained, on the one hand, by increased evacuation of water through the exhaled air in the form of water vapor due to hyperventilation and, on the other hand, by a drop in the filtration function of the kidneys as an effect of reduced partial oxygen pressure.

Finally there was a slight increase in the amount of nitrogen excreted with the urine during the altitude test in comparison to the control tests. This might be explained by peculiarities in the regulating mechanisms of urine secretion in dogs.

The consumption of oxygen at 5000 m after meat consumption somewhat increased at first as in the control tests; thereafter, a slight decrease was observed and, finally, between the 6th and 7th hours, the absorption of oxygen increased again. The same was true of carbon dioxide liberation. During the first few hours at 5000 m, the amount of liberated carbon dioxide increased by approximately 10 to 20% in both dogs then decreasing during the 2nd, 3rd, and 4th hours. Finally, toward the end of the test it increased to a figure 20 to 30% above the original figure.

The data showed that in the control series the amount of amino and residual nitrogen in the blood of the dogs increased perceptibly within two hours after meat consumption. At the end of the test (after 4 hrs) this amount

decreased to the original level. A different phenomenon occurred at reduced atmospheric pressure. In this case, contrary to the control tests, these indices reached their maximum level by the 6th to the 7th hour after meat consumption. It was found that the highest increase in nitrogen discharge occurred 6 to 8 hrs after meat consumption.

Summarizing the data from both test series, it was concluded that after a meat consumption, nitrogen metabolism as well as the gas metabolism in animals breathing air at reduced pressure undergoes definite and, in some cases, rather sharp variations compared to normal conditions.

These data seemed to justify the assumption that in evaluating the effects of hypoxemia, quantitative and the qualitative aspects of metabolism should be considered. [CD]

7. Effect of Reduced Pressure on Activity of Cytochrome Oxidase

SOURCE: Sulimo-Samuyllo, Z. K. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 111-115.

An earlier (1952) investigation has indicated that oxidation processes in an animal subjected to reduced oxygen pressure are characterized by phase variations relative to the degree of oxygen deficiency. Thus, the tissue respiration of sections of the liver, kidneys, spleen, and cerebrum in guinea pigs exposed to a pressure of 276 mm Hg for 1.5 hours increased considerably but decreased sharply after a 3-hour stay under the same pressure. This phase variation in tissue respiration was interpreted as a result of enzyme disturbances in the blood and in the tissues. To verify this assumption, the effect of severe oxygen deficiency on cytochrome oxidase (one of the most important enzymes that participate in the oxidizing processes) activity was studied.

Because of their sensitivity to oxygen deficiency, guinea pigs were again used as test animals. The animals were placed into a pressure chamber and subjected to the action of a rarefied atmosphere corresponding to 8000 m altitude (267 mm Hg) for 1.5--3 hrs. At the end of this period, the animals were killed and the cerebral hemispheres, liver, kidneys and spleen were removed as quickly as possible. Small specimens of tissue were prepared on a torsion balance and then ground in porcelain mortars, followed by the addition of a phosphate buffer (pH 7.2) to obtain a 4% tissue suspension. Some results of this study are shown in Fig. 4.

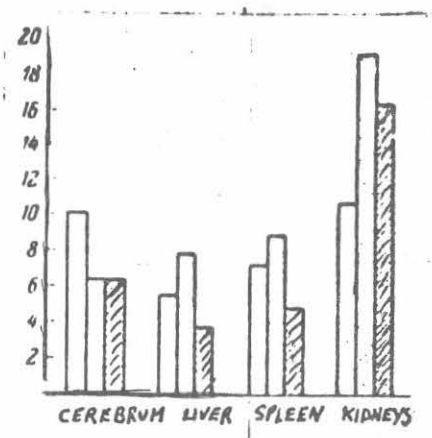

Fig. 4. Variation in tissue respiration of various organs, depending on duration of stay of the guinea pigs in conditions of a rarefied atmosphere (267 mm Hg). The amount of oxygen in mm^3 per mg of dry substance is plotted on the Y-axis. White columns denote the normal oxygen consumption by the tissues; dotted columns represent oxygen consumption by the tissues after 1.5-hour exposure of guinea pigs in pressure chamber; columns with oblique shading show oxygen consumption after a 3-hour stay in the pressure chamber.

The drop in tissue respiration and in cytochrome oxidase activity after exposing the animals to reduced partial oxygen pressure for 3 hours testifies to the establishment of the biochemical processes on a new physiological level of activity. The phase variation in oxygen consumption is typical of both oxygen deficiency caused by the change in partial oxygen pressure in the surrounding medium, and of other forms of oxygen deficiency. In his study devoted to the shock effects, M. G. Danilov (1943)* noted variations in tissue respiration relative to the state of the central nervous system, the increase in gas metabolism and in tissue respiration at the stage of excitation, and the depression of the metabolic processes at the onset of shock. The phase variation in oxygen consumption was detected by V. A. Negovskiy (1949) while observing the restoration of vital functions in an organism which had survived a state of clinical death. Negovskiy pointed out that during the early period of restoration the tissues showed slight oxygen consumption which increased as the functions of the central nervous system were restored. Thus, in the present study, it can be hypothesized that the phasic nature of variation of the oxidizing processes, which indicates the readjustment of trophic function during oxygen deficiency, is determined by an altered functional state of the central nervous system. However, a more ob-

jective criterion for proper judgement of the functional state of the central nervous system is needed.

The observed variations in tissue respiration and in the oxidizing enzyme (cytochrome oxidase) activity which occur at the early stages of acute oxygen deficiency, obviously form the basis for the acclimatization process. During repeated continuous exposure to a rarefied atmosphere, these variations are converted into a habitual reaction of the organism and become permanently fixed, thus ensuring the adaptation of the organism to conditions of insufficient oxygen supply.

On the basis of this study, it can be concluded that 1) cytochrome oxidase activity in the gray matter of the cerebral hemispheres, liver, and spleen of guinea pigs subjected to the effect of a rarefied atmosphere corresponding to 8000 m altitude varies relative to the duration of the animals' exposure to conditions of low partial oxygen pressure, increasing with short exposure (1.5 hrs) and decreasing with more prolonged exposure (3 hrs); 2) the highest cytochrome oxidase activity is observed in tissues that show the highest sensitivity to oxygen deficiency (the gray matter of cerebral hemispheres and the liver). [SC]

*Danilov, M. G. Byull. eksper. biol. i med. (Bulletin of experimental biology and medicine), Vol. 15, Issues 1 and 2, 1943.

8. Absorption of Certain Digestion Products and Saline Solutions in Various Stages of Hypoxemia

SOURCE: Fu Fon-hao. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 116-121.

It is known that oxygen deficiency causes a number of changes in the organism, including changes in the digestive system. It seemed, therefore, desirable to investigate the absorptive function of the small intestine during oxygen deficiency under conditions of chronic experimentation. This included a study of the absorption of carbohydrates, proteins, sodium chloride and distilled water in the intestine of dogs during various stages of hypoxemia.

The study was conducted on three dogs tested after 18 to 20 hours of starvation. The preparation of the dogs was conducted according to a method developed by a department member, V. M. Frolov, consisting of the following: using the Teary-Vella method, an isolated loop is made of the upper part of the small intestine about 35 to 40 cm long. Metal cannulas are inserted into either end of the isolated loop. The cannulas are secured in both sectors of the intestine by two strong silk ligatures with invagination of the intestine sector, as shown in Fig. 1.

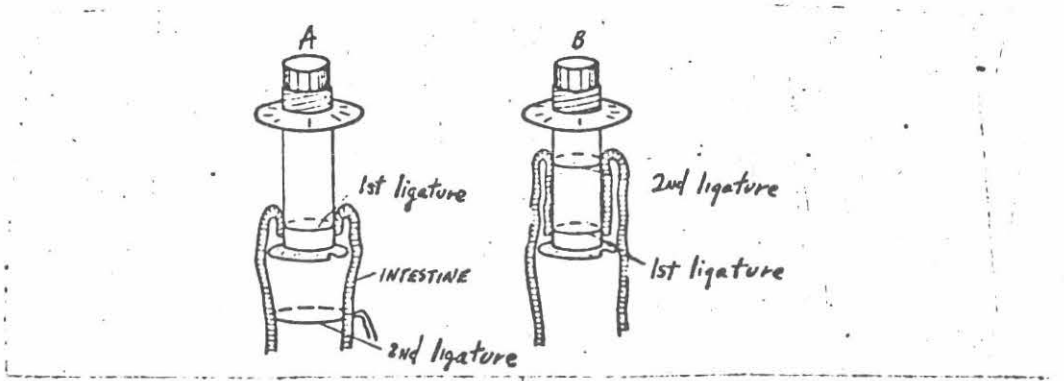

Fig. 1. Schematic view showing the positions of the ligatures during operation. A is the application of the first ligature; B is the application of the second ligature.

After applying the second ligature around the cannula, the omentum is secured and the cannulas are fixed to the abdominal wall in the usual way. The stomach wound is sutured. This operation ensures good hermetic sealing in the isolated loop of the intesting and easy introduction and extraction of the solutions under study. The postoperative period lasts about two weeks.

Figure 2 shows a dog during the test. Two funnels are attached to the cross beam of the stand and are connected by rubber tubules with the intestinal cannulas. The test solution is introduced into the distal funnel; the liquid proceeds to the proximal end of the isolated intestine.

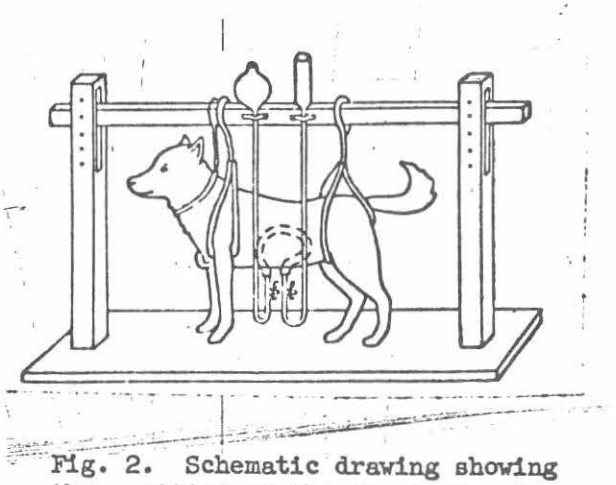

Fig. 2. Schematic drawing showing the position of the dog during the test.

The absorption of the following substances was investigated in succession: distilled water, 4% solution of glucose, 1% solution of glycocoll, and physiological solution. The test substances were introduced into the intestinal loope after preliminary warming up to a temperature of 38°, in the amount of 1 ml, for a duration of 15 minutes; thereafter, the amount of solid matter in the remaining solution was determined. The amount of solid glucose in the remainder of the solution was determined by Fehling's method, glycocoll by Soerensen's method, and sodium chloride by Folhard's method.

A total three series of tests were conducted. The first series was conducted in the pressure chamber at normal pressure, the second series at 4000 m, the third

series at 8000 m. The sequence of the tests, the regimen, and maintenance of the animals was constant.

The data showed that the absorption of glucose and glycocoll during various stages of hypoxemia is subject to slight variations, whereas the absorption of water is altered substantially.

Variations in the absorption of water are apparently caused by a substantial loss of water during hyperventilation and by biochemical disturbances caused by oxygen deficiency, while the variations in the absorption of sodium chloride are associated with disorders in the acid-base equilibrium of the organism.

In general: 1) The absorption of water during repeated tests decreased at 4000 m, but increased considerably at 8000 m. 2) The absorption of glucose and sodium chloride is subject to changes only during advanced stages of hypoxemia. 3) The absorption of glycocoll during hypoxemia at the tested altitudes showed no substantial changes. [CD]

9. Morphological Shifts in the Spinal Cord of Animals after a Prolonged Stay in a Rarefied Atmosphere

SOURCE: Kurkovskiy, V. P. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 122-136.

The present study is essentially a continuation of an earlier report on the morphological state of the spinal cord and the spinal ganglia during single and multiple exposures of sharply reduced barometric pressure on the organism of animals (1955). The most essential conclusion reached at that time indicated that the chronic effects of oxygen deficiency noticeably impaired the condition of the spinal cord and the spinal ganglia. The changes which, as a rule, were reversible now showed a marked increase and became partly irreversible, although this was not substantially reflected in the functional state of the animals after the test.

Later, a morphological analysis was conducted on animals exposed to a rarefied atmosphere for prolonged periods (4 to 5 days). The results of these investigations are given in this report.

The dissected material for histological examination was taken from 6 cats which had been used by B. A. Dolgo-Saburov to study morphological changes in venae cavae receptors under conditions of oxygen deficiency. Tests were conducted as follows: all animals were placed in a pressure chamber and initially kept there for 24 hours each at "altitudes" of 5000, 6000, 7000, and 8000 m. The test was interrupted once a day for 10 minutes for feeding purposes. At 7000 and 8000 m elevation most cats initially exhibited synptoms of drowsiness and accelerated respiration, but thereafter quickly adapted themselves to these conditions and showed no visible physiological disorders.

By the end of the fourth day two cats were killed. The other animals were taken up on the 5th day to an altitude of 10,000 m. After 1.5 hours general spasms developed in another cat (#3) which was immediately killed. After 13.5 hours general spasms developed in cat #4 which was killed. The last two animals (#5 and 6) were kept at 10,000

m for 22 hours. One of them (#6) endured this condition easily, but the other one was in a very weakened condition. The cats were then "grounded" for one hour for feeding and rest whereupon they were once more taken up to 12,000 m. After 5 minutes the test had to be interrupted as general spasms developed in cat #5. Right after descent the animal was killed. Cat #6 was not subjected to any further ascent and was killed after 14 days. No substantial functional disorders were observed in this cat during this period. An autopsy was performed immediately after the death of the animals. A morphological examination of all sections of the spinal cord, the corresponding spinal ganglia, and both first thoracic sympathetic (stellate) ganglia was conducted. In cat #6, both superior cervical sympathetic ganglia, the gasserian ganglia, and the g. nodosum of the vagus nerves were examined.

The following conclusions were drawn: 1) A prolonged (4 to 5 days) stay by cats in a rarefied atmosphere corresponding to altitudes ranging from 5000 to 12000 m, produces substantial morphological changes in the spinal cord and the intervertebral and stellate sympathetic ganglia; 2) The most sensitive structures are small cells of the intermediate zone of the spinal cord and also diffusively disseminated small cells located in other parts of the gray matter. 3) An increase in exposure duration or altitude intensifies changes in the spinal cord, which become localized mainly in the caudal segments. 4) In the intervertebral ganglia of a number of animals clearly pronounced degenerative changes in neural cells were detected which are widely spread among insignificantly altered or apparently normal neurons. Also found were signs of excessive growth of neural fibers. These signs are characterized by the formation of pericellular glomera. 5) Substantial structural disorders were noted in the stellate sympathetic ganglia of several animals. In one case an overwhelming majority of irreversible changed neural cells were observed. 6) Animals subjected to oxygen deficiency and kept under identical experimental conditions may exhibit considerable individual differences in the degree to which the neural cells are affected in the spinal cord and in the spinal and sympathetic ganglia. [CD]

10. Changes in Altitude Resistance as a Result of Pressure-Chamber Training

SOURCE: Vasilenko, M. Ye., O. G. Gazenko, P. M. Gramenitskiy, A. G. Zhironkin, V. N. Zvorykin, and A. G. Kuznetsova. IN: Akademiya nauk SSSR. Institut evolyutsionnoy fiziologii imeni I. M. Sechenova. Funktsii organisma v usloviyakh izmenennoy gazovoy sredy (Functions of the organism under conditions of an altered gas medium), v. 2. Moscow-Leningrad, Izd-vo AN SSSR, 1958. 137-152.

It is known that pressure-chamber training is the most convenient and effective method of increasing human altitude resistance of man. Nonetheless, a number of physiological problems associated with pressure-chamber training requires further study. First, the cause of the high variation in the training effectiveness is not clear. Second, there is disagreement as to the reliability of the various indices of pressure training effectiveness. For example, it was long accepted that the most reliable index of increased altitude resistance during pressure training was an increase in the content of hemoglobin and erythrocytes.

At the present time, numerous studies indicate that on one hand, the increase in altitude resistance may not correspond to an increase in hemoglobin and erythrocytes, while on the other hand, an increase of these indices may correspond to a reduction in altitude resistance. Despite some isolated studies made in this direction, there still remains considerable doubt as to changes in the functional state of higher sections of the central nervous system during the course of pressure-training and the dependence of increased altitude resistance on these changes.

The purpose of our study was a) to comprehensively verify a number of indices of the effectiveness of pressure chamber training through a comparison of these indices with results of a direct determination (measuring the so-called time reserve) of altitude resistance; b) to clarify certain peculiarities of the course of pressure-chamber training and its effect on various people; c) to compare data on the functional state of the higher sections of the central nervous system during ascents in a pressure chamber with changes in altitude resistance.

The experiment was carried out on 35 subjects. Prior to the tests subjects underwent a thorough medical examination, on the basis of which, a decision was made individually on the advisability of ascents in the pressure chamber. The time reserve for an altitude of 7500 m with-

out oxygen was determined before and after training. The results of these ascents were used as a baseline data.

During the time reserve test, a thorough observation of the general condition of the subjects was conducted, an electrocardiogram (ECG) and electroencephalogram (EEG) were taken, a so-called writing test was administered, and a blood count was made (erythrocytes and reticulocytes and determination of hemoglobin by Sahli's method).

The general schedule was as follows: all subjects were tested for time reserve at 7500 m without oxygen. Pressure-chamber training for each subject started 3 days later and involved ascents every third day to 5000 m for 1 hour. (An altitude of 5000 m for 1 hour is sufficient to cause noticeable changes in the organism of an untrained man). Altogether there were five ascents.

A control ascent to determine time reserve was made three days after the experiment. The control ascents went as follows: 1) The subject was instructed before the ascent; ECG and EEG were taken. 2) The ascent was conducted with an oxygen mask to 7500 m (286.8 mm Hg). 3) At this altitude the subject breathed oxygen for three minutes and performed a writing test. 4) The supply of oxygen was then cut off without warning. The subject continued the writing test until the onset of the first symtoms of acute oxygen starvation and obvious working capacity disorder. Immediately thereafter, oxygen supply was resumed and the descent began. Every three minutes the subject had to draw a line on a blank form and make notes on his condition. An ECG and EEG were taken during this test. 5) Three minutes after descent the subject was asked to describe his sensations at the experimental altitude.

An evaluation of variations in altitude resistance was made on the basis of the time reserve at 7500 m. This altitude was selected because the time reserve fluctuates between 6 and 12 minutes, which is sufficient for carrying out the necessary measurements. At lower altitudes the time reserve is determined with difficulty, since the symptoms develop at a slow rate and the pattem of altitude disorders is frequently obliterated. At altitudes higher than 7500 m the time reserve is extremely short, which hampers the performance of the necessary studies.

The following conclusions were drawn: 1) The altitude resistance of the majority of subjects increases as a result of pressure-chamber training. 2) A direct determination of the altitude resistance by establishing the

time reserve of the subjects shows that an increase in resistance is observed in 72% of the cases, a decrease in 17% and no change in 11% of the cases. 3) Best results were obtained by training subjects with low altitude resistnace and small time reserve. A decrease in altitude resistance was primarily observed in subjects who initially exhibited medium or good resistance to altitude. 4) The handwriting test is a reliable index for studying the activity of the higher sections of the central nervous system and for evaluating the human working capacity during altitude tests. 5) A change in the bioelectric activity of the brain is observed under conditions of acute oxygen starvation; this change is reflected in an activation of alpha wave activity, a gradual drop in oscillation frequency, and substantial EEG changes in the frontal zone. 6) There is a dependence between altitude resistance and changes in the brain bioelectricity at high-altitudes. 7) Changes in cardiac activity at high altitude were observed. There was an increase or decrease (very seldom) in systole frequency, a decrease in the electromotive force of cardiac bioelectricity, and displacement of the electric axis of the heart to the left as a result of abdominal distension and upward displacement of the diaphragm. 8) An increase in the hemoglobin, erythrocytes and reticulocytes count occurs in the majority of cases during pressure-chamber training. 9) The most complete evaluation of the effectiveness of pressure-chamber training can be made through a complex examination of subjects, e.g., time reserve, electroencephalography, handwriting test, electrocardiography, blood test, etc. A consideration of only one of these criteria cannot always yield an accurate index of the effectiveness of pressure-training. [CD]

11. Studies of the Mechanism of Hypoxic Hypotension in the Rat

SOURCE: Takacs, L., and K. Albert. IN: Academia scientiarum Hungarica. Acta physiologica, v. 25, no. 4, 1964, 399-401.

The effect of sympatholytic, parasympathicolytic, ganglionic blocking, antihistaminic and anti-serotonin agents on hypoxic hypotension was studied in male rats weighing 150 g each. In addition, arterial hypoxia was examined in relation to blood pressure with CO_2 added to the hypoxic mixture. The rats were kept fasting for 16--20 hrs and then anaesthetized with 40 mg/kg of intraperitoneal sodium pentothal. The animals inhaled a hypoxic gas mixture (6% O_2 and 94% N_2) for 3 min. Inhalation of the hypoxic mixture was repeated after a 4--8 min interval. The first exposure to hypoxia served as the control; the test substance was administered between the 1st and 2nd exposure to hypoxia. Blood pressure was read every minute; and the animals' responses were evaluated from the results obtained at the end of the 3d minute. The tested agents were given intravenously after the first hypoxic period in the following doses: dibenzyline, 7.5 mg/kg; atropine, 1.0 mg/kg; azamethonium, 6.1 mg/kg; chloropyramine, 1.4 mg/kg; 1-methyl-d-lysergic acid-butanolamide (made by Desiril Sandoz), 0.4 mg/kg. The effect of histamine, adrenaline, and serotonin on blood pressure was examined before and after administration. Chloropyramine almost completely suppressed the effect of histamine, dibenzyline caused a reverse effect of adrenaline. The injection of 30 mg/kg serotonin (before administration of 1-methyl-d-lysergic a acid-butanolamide) reduced normal mean blood pressure (117 mm Hg) by 35%; 3--6 min later it lowered 106 mm Hg blood pressure by 12%. Table 1 shows blood presssure values measured before the first and second hypoxic periods, as well as the percent decreases by the end of exposure to hypoxia. The differences between the changes were evaluated by two-sample *Student "t"* tests. The basal blood pressure of the control group did not change during the interval separating the two hypoxic periods. During hypoxic periods blood pressure decreased by an an average of 46 and 50%, respectively. The difference was not statistically significant. Dibenzyline, atropine, azamethonium chloropyramine and 1-methyl-d-lysergic acid-butanolamide had no influence on the hypotensive response to hypoxia. Blood pressure decreased by 35% with CO_2 added to the mixture. The difference was fairly significant.

	Dose mg/kg i.v.	Number of cases (n)	I. HYPOXIA (control) Mean blood pressure, mm Hg		II. HYPOXIA (+ treatment) Mean blood pressure, mm Hg		t	P
			At onset of hypoxia	Percentage decrease	At onset of hypoxia	Percentage decrease		
control	—	17	115.0	46.2 ± 16.9	114.7	49.5 ± 14.9	0.603	>0.50
dibenzyline	7.5	10	119.5	32.2 ± 17.9	99.5	30.7 ± 11.7	0.180	>0.80
atropine	1.0	22	108.9	40.3 ± 17.0	104.1	36.2 ± 15.2	0.840	>0.40
azamethonium	6.1	10	109.5	38.2 ± 12.9	91.0	32.1 ± 12.4	1.070	>0.20
chloropyramine	1.4	11	119.1	46.4 ± 16.4	115.9	37.8 ± 20.2	1.100	>0.20
1-methyl-d-lysergic acid-butanolamide	0.4	12	116.7	49.9 ± 12.4	105.4	53.4 ± 12.6	0.685	~0.50
5 per cent CO_2	—	36	109.3	43.6 ± 18.5	109.2	34.8 ± 20.5	1.905	>0.05

Table 1.

In the opinion of the authors, the drop in blood pressure, i.e., the systemic vasodilatation, is apparently independent of nervous mechanisms nor can it be traced to a release of histamine or serotonin. Hypoxic hypocapnia is only partially responsible for the drop in blood pressure. These investigations indicate that in the rat, hypoxia may directly dilate the blood vessels. Eventually, humoral factors other than serotonin and histamine may also be involved. [SC]

Section VII. Air Purification and Problems of Ship Drinking Water Systems

1. Chemical Air Purification and Production of Oxygen

SOURCE: Mel'nikov, A. Kh., and T. P. Firsova. Interaction of sodium superoxide with water vapor at low temperatures. Zhurnal neorganicheskoy khimii, v. 6, no. 1, Jan 1961, 169-176. QD1.A3753, v. 6. (S/078/61/006/001)

This article is a study of the interaction of technical sodium superoxide (NaO_2, 85% pure) with water vapor at -10, -5, 0, and +20°C. The study was undertaken to offset the lack of information on interactions of sodium superoxide with other substances. The technical substance used in the experiments also contained sodium peroxide, sodium hydroxide, sodium carbonate, and small amounts of other impurities.

At temperatures from -10 to 0°C, oxygen and hydrated sodium peroxide were the end products. The octohydrate ($Na_2O_2 \cdot 8\ H_2O$) was the most stable hydrate. The amount of heat evolved in the reaction was determined. Rather rapid water-vapor absorption and comparatively slow evolution of oxygen were found to occur. The decomposition reaction seemed to be limited to NaO_2.

At +20°C, however, both NaO_2 and Na_2O_2 rapidly decomposed with rapid evolution of oxygen and heat. Hydrated sodium hydroxide ($NaOH \cdot H_2O$) was the solid end product of the reaction.

In the writer's opinion the article is indicative of continuing Soviet efforts to find the most economical method of employing oxygen-producing reagents for air purification in closely confined areas (e.g., in manned space vehicles). The specific gravity of the first intermediate of NaO_2, the octohydrate of Na_2O_2, was specially determined. The value found, 1.56, is noted in the authors' resume of the article, apparently as a significant figure. Temperatures for the study (from -10 to +20°C) were obviously selected to simulate biologically acceptable conditions. Heat evolution in the potential air-purification reaction was determined at least in part by the renewal of the oxygen supply. A similar study, on the interaction of lithium peroxide with water vapor and carbon dioxide, was reported in AID Report 60-59, Item of Interest, 27 Sep 1960. Sodium superoxide was first synthesized in the Soviet Union by I. A. Kazarnovskiy in 1936. This indicates the long-standing Soviet interest in higher oxides of alkaline metals.

2. Preboiler methods of treating drinking water

SOURCE: Vladivostok. Dal'nevostochnyy tekhnicheskiy institut rybnoy promyshlennosti i khozyaystva. Trudy, no. 3, 1963, 97-107

The following figures show various methods of processing drinking water.

The article concluded that it is economically expedient to supply steam boilers with processed water; the expenses for water purification will pay for themselves in not more than 1—2 years and the reliability and endurance of the boiler is ensured. The cation methods of processing water are recommended for all types of boilers and water. Magnetic processing of water can be applied in treating water for flue and tubular boilers with pipe diameters 76 mm and greater and thermal stress less than 30 kg/cm^2. Deaeration of drinking water is necessary for all industrial boilers. Thermal deaeration in atmospheric type devices is the most effective and reliable in operation. [SW]

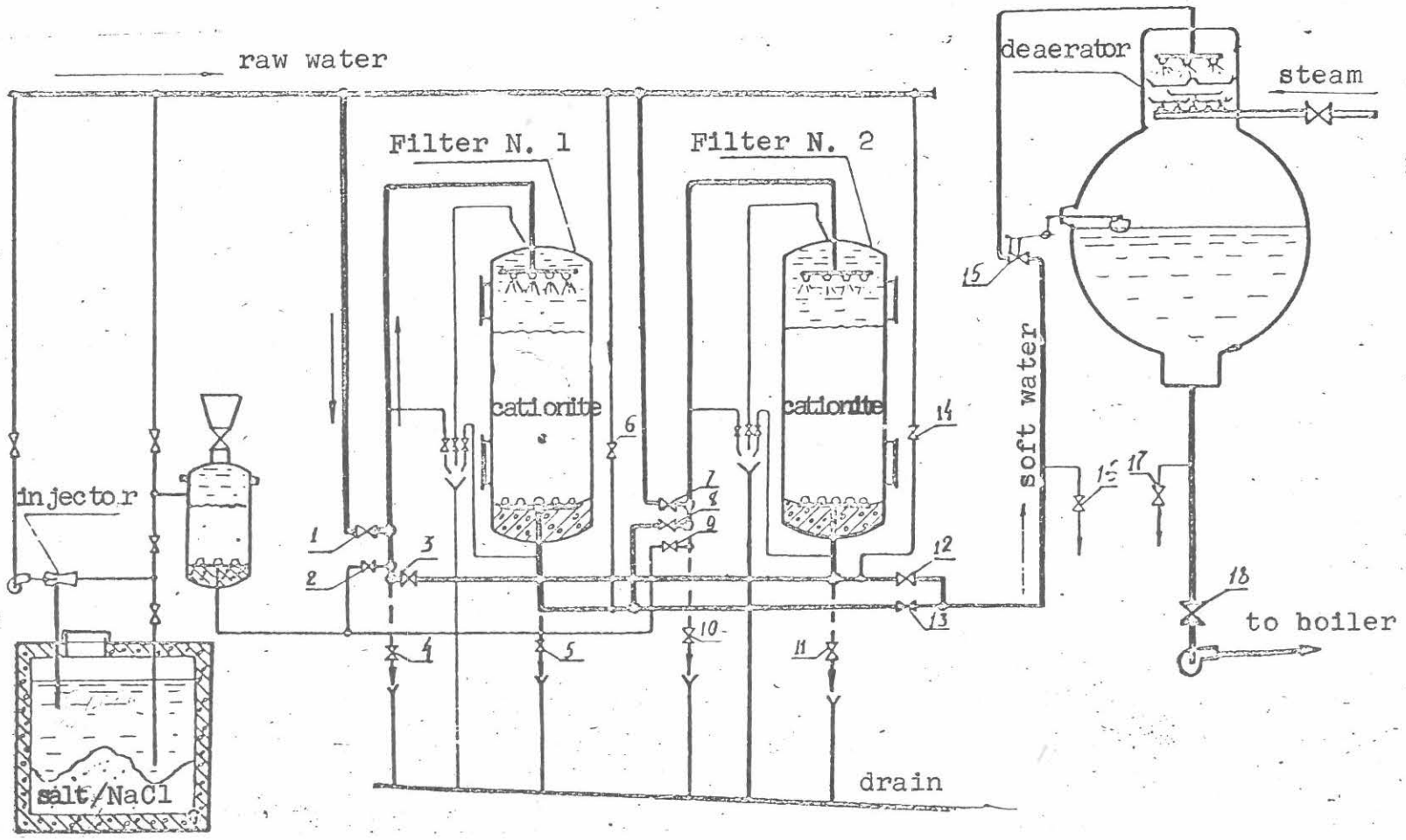

Fig. 1. Two stage cation treatment of water.

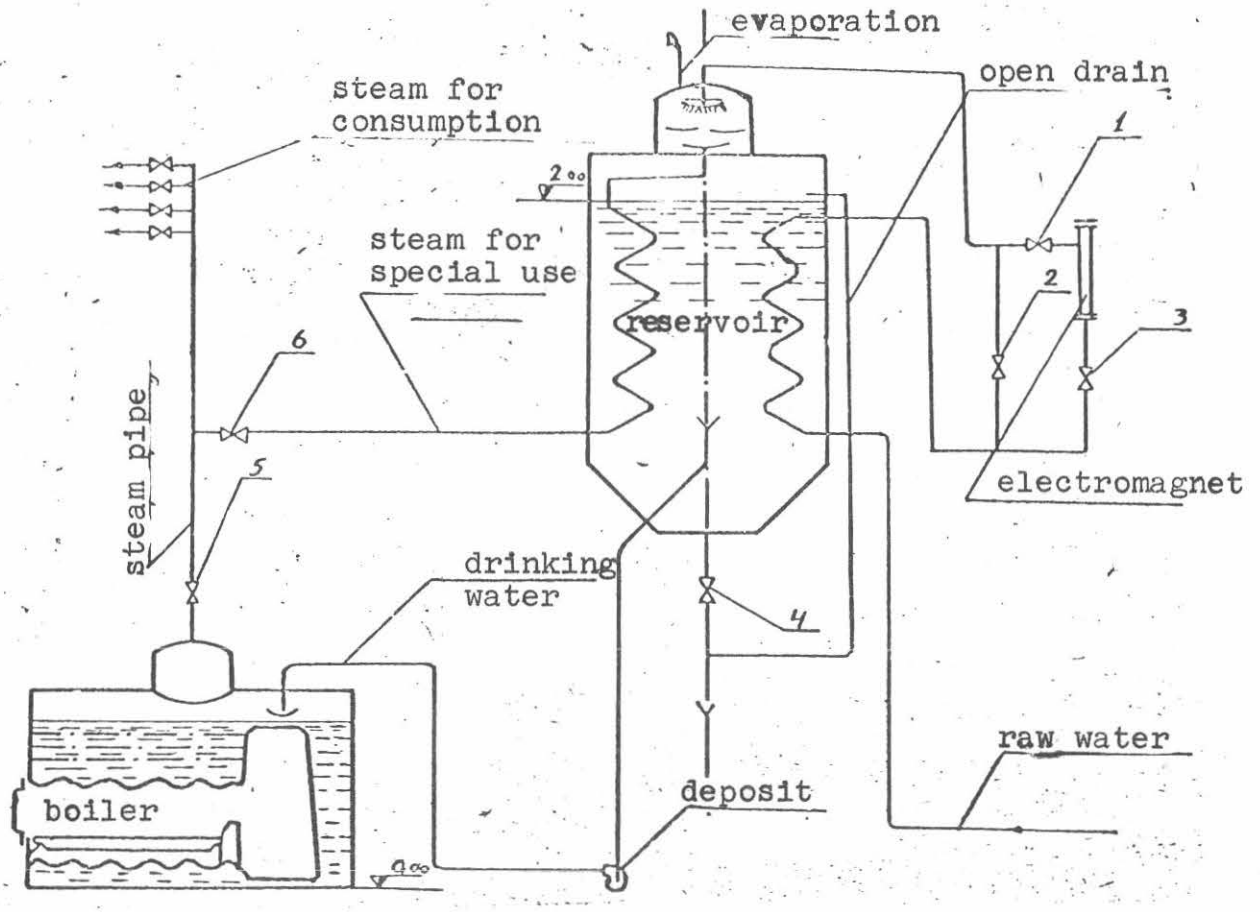

Fig. 2. Diagram of the electromagnetic processing of drinking water.

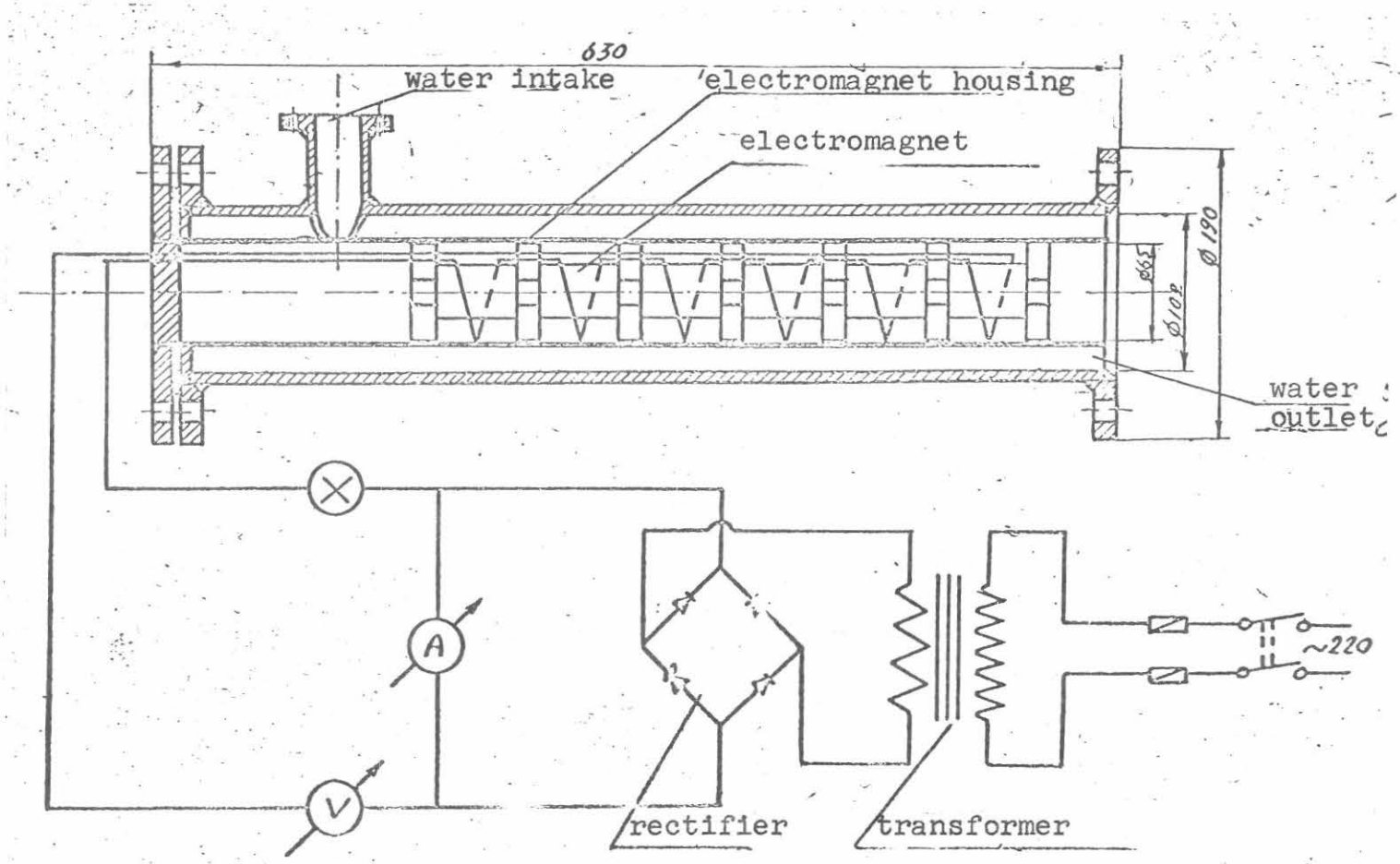

Fig. 3. Diagram of the electromagnet circuit

3. Maintainance of Shipboard Drinking Water Storage Systems

SOURCE: Morskoy Sbornik, no. 10, 1965, 65-69.

This article examines the procedures and protocols for maintaining and preparing water storage systems. The steps involved in preparing such systems are discussed and listed as: 1) cleansing cisterns and pipes; 2) cementing the interiors of cisterns; 3) disinfecting cisterns and pipes; 4) testing the operating storage system. The whole process is said to require 14 days and is strictly supervised and conducted according to military medical service regulations. A detailed breakdown of the process is given in Table 1. [CD]

Table 1. Schedule of steps involved in preparing a shipboard drinking water storage system.

Operation	Time (hr)	During cruise
Steaming and cleaning pipes	8	
Cementing the cisterns		
First layer	15	24
Second layer	25	36
Third layer	24	36
Soaking filled cisterns	48	
Cistern chlorination	24	
Water storage before analysis	120	
First Analysis	72	
TOTAL	336	

4. Scientists Describe Water Softening Techniques

SOURCE: Moscow TASS International Service in English 0751 GMT 9 December 1966--L

(Text) Moscow--Soviet specialists intend to prevent water shortages in some areas of the country by using softened seawater.

Designs are in the making in the Ukraine for building a 100--kilometer canal from the Sea of Azov to the Donetsk Basin. It has been estimated that further industrial development of this large area may result, 10 years from now, in a deficit of 1 billion tons of water per year.

Two powerful water-softening installations, with a daily output of more than 300,000 cubic meters of water, are to be built simultaneously with the canal.

In two years the atomic water-softening installation now under construction in the city of Shevchenko on the Caspian Sea coast will be able to produce 120,000 cubic meters of water daily. Its cost--5.7 copecks per cubic meter-- will be very close to that of running water.

A 1 million-kilowatt reactor on fast neutrons will be installed at the nuclear station. Besides water, the reactor will give the city millions of kilowatt-hours of electricity every day.

Soviet specialists will describe atomic water softening installations at the second European symposium "Sweet Water from the Sea" to be held in Athens next spring. One of the reports will be devoted to a water softener of a new type. A molecular sifter with the mesh, of a size of not quite 1 millionth of a millimeter, will be its main part.

This sifter lets molecules through but retains the ions of the dissolved salts. More than 500 liters of sweet water can be obtained in 24 hours from a square meter of such a filter.

Soviet scientists will tell the symposium about an installation for water supply in small settlements in deserts and semideserts. This is particularly important for the southeastern part of the country where 2.5 million square kilometers of land have no sweet water but are rich in useful minerals. According to specialists' estimates the Soviet Union will need more than 50,000 such machines in the next few years.

Section VIII. Miscellaneous (Bionics and Bioacoustics)

1. Bionics and Bioacoustics

SOURCE: Prof. Dr. N. Naumov (Lomonosov State University). Berliner Zeitung (E. Germany), 21 November 1965, p. 4 (Supplement), cols. 1-3. (Summary)

Studies in bionics and bioacoustics based on the modeling of the orientation and other systems of animal life will be of great importance in future research in technology, according to Prof. Naumov. Dolphins have been found to use vibration frequencies of 120 to 200 kc for object-space orientation. The precision of their hydrolocation-finding apparatus is better than those developed by man. Dolphins can even sort fish by type. The accuracy of dolphin position finding is based on their ability to use sound of different frequencies operationally. Hydroacoustic devices developed by man lag far behind. Bats have been found to transmit 10—13 msec impulses at a frequency of 8 to 10 impulses per second. When an insect enters the area being scanned, the impulse frequency increases and reaches some 200 impulses per second. It is not yet understood how bats that rarely transmit long impulses in flight sense a rapidly flying insect. The author presents some speculations on this problem and proceeds to explain other electromagnetic phenomena characteristic of certain birds and fish. The sensitivity of animals, especially fish, to electric current is also under study. Some experiments are described. Study of the stabilization organs of insects made it possible to develop a "gyrotron device." The structure of the eye of a beetle helped in the designing of a speedometer to determine the speed of aircraft relative to the earth. Autopilots have been developed on the model of the function of bird stabilization systems. Attempts have been made to detect submarines by observing the behavior of seals, the author concludes. [JS]

2. Investigations of Marine Biological Sounds

SOURCE: Shishkova, Ye. V. Investigations of marine biological sounds with the aim of using them for the location of fish IN: Rybolovnyy flot, Izd-vo "Sudostroyeniye", vol. 2, 1965. 373-374

The present use of hydroacoustic instruments permits fish to be located at greater distances and depths. The vertical and horizontal dimensions and density of schools can also be determined. However, there is yet no hydroacoustic instrument for determining the species composition of a school of fish. To develop such an instrument, it is extremely important to study sounds generated by the fish in their environment. This problem entails a complex series of hydroacoustical experiments. First of all, it is necessary to determine whether the biological noises of the fish occur with enough regularity and sufficient intensity to justify a special apparatus for their detection. As a result of an experiment conducted by VNIRO it was established that some species emit intensive noises through floating bubbles. These fish were observed from the end of spring to the beginning of autumn. The sounds of different fish varied according to frequency, rhythm, and signal duration. The sound activity of the fish also varied according to season. During the spawning period, fish are most acoustically active. The problem of further developing experiments dealing with marine biological sounds has great significance for the fishing industry. Observations using hydrophonic equipment should be combined with sonic surveys to contrast the sound activity of the fish with the structure of a school of fish. (In the conclusion of his explanation, the author Ye. V. Shishkova demonstrated a compound phonogram of the sounds of the fish and the dolphins in the Black and Azov Seas). [SC]

3. Ultrasonic Transmitter Records Fish Movements

SOURCE: I. Tverskoi. Science and Engineering. APN Newsletter Novosti Press Agency, (USSR), no. 46, 1965. pp. 6-8. (Summary)

A tiny ultrasonic transmitter (12 g) has been developed which can be attached to fish to trace their movements. Signals from sturgeon tagged in the Volgograd area were picked up by receivers on ships. In addition, the ships carried transducers to monitor around-the-clock changes in the temperature and electrical conductivity of water, its illumination and dissolved oxygen content, and the speed of the current. Many interesting facts about the movements of sturgeon were discovered with this equipment. Apparently sturgeon use depth, the direction and speed of the current, and temperature gradients to determine their migration routes. The experimenters also noted the reaction of fish to the noise of passing ships and the effect of barometric pressure and other weather changes on fish activity.

4. Talking Starfish

SOURCE: Vodnyy transport (USSR), 7 December 1965, p. 4, col. 3. (Summary)

Studies of the "speech" of fish are conducted by the Pacific section of the Institute of Oceanology, Academy of Sciences USSR. The following was observed: A crab bit off two rays of a starfish. After an undetermined signal, large starfish grouped together to conceal the smaller starfish from the crabs.

5. The "Language" of Starfish

SOURCE: Sovietunion Heute (USSR), 16 February 1966, p. 14, col. 1. (Summary)

The scientists of the Pacific section of the Oceanographic Institute, Academy of Sciences USSR, have observed the amazing capacity of some deep-sea dwellers to "talk" to each other. Even the starfish, which up to now have

been regarded as "mute," evidently can exchange signals among themselves. Crabs were put in an aquarium with starfish and it seemed at first that they would attack the starfish. Then the scientists witnessed an unusual occurrence. The star-fish suddenly, as if on order, gathered together in one place and the larger ones began protecting the smaller ones against the claws of the crab with their bodies. Observations are being continued to better understand the "language" of the starfish.

6. Soviet Infrasonic Storm-Warning Signal

SOURCE: B. J. Witkowski. Horyzont; Zolnierz Wolnosci (Poland), 1 October 1965, p. 4, cols. 5-6. (Summary)

An electronic infrasonic automatic storm-signaling device has been developed at the Lomonosov Moscow University. Mounted on seagoing ships, the device will be able to give storm-warning signals 15 hours in advance. The concept of the device is based on the "infrasonic ear" of jellyfish.

7. New Aquarium

SOURCE: Sovetskaya Belorussiya (USSR), 26 November 1965, p. 4, col. 1. (Summary)

The largest marine aquarium in the USSR is being completed in Batum, at the Georgian scientific-research fishery station. For research work, the experimental marine laboratory has 40 vessels and 3 open basins.

8. Dolphin Resembles Flying Wing

SOURCE: Tekhnika i molodezhi (USSR), no. 12, 1965, p. 6, cols. 2-3. (Summary)

Doctor of Biology Yu. Aleyev of the Institute of Biology of the South Seas states that dolphins in motion resemble flying wing aircraft more than they do submarines. Since the dolphin is heavier than water, it must stay in motion to stay afloat. The lifting force is provided by the pectoral fins. Aleyev suggests that the outline of the dolphin without the fins closely resembles that of the "B" type aviation wing of the Zhukovskiy Central Aerodynamic Institute. Model experiments were conducted with dolphin models in which it was seen that the lifting force at a critical high speed could be supplied by the dolphin model itself without the need of expending additional energy.

9. Studies of Dolphins

SOURCE: Sovetskaya Latviya (USSR), 14 January 1966, p. 4, cols. 1-2. (Summary)

The behavior of dolphins is studied at the Institute of Morphology, Academy of Sciences USSR, and at the Moscow State University. Clicking by dolphins when pleased and squeaking when excited are clearly audible. Dolphins are very trustful, curious, and show no antagonism to humans.

10. Soviet Dolphin Research

SOURCE: L. Repin, Komsomol'skaya Pravda (USSR), 26 February 1966, p. 4, cols. 3-7. (Summary)

Three Soviet scientists engaged in dolphin research and the authors of a book "The Riddle of the Ocean" were interviewed about their work. They were Doctor of Biological Sciences S. Ye. Kleynenberg, Candidate of Biological Sciences V. M. Bel'kovich, and Doctor of

Biological Sciences A. V. Yablokov. The work of the American researcher John Lilly was mentioned. The three men, all morphologists, were especially interested in certain parts of the dolphin's brain which function as relay switches and participate in various associative processes, although their exact function is unknown. It was recently postulated that one of these centers controls breathing, previously considered a reflex in dolphins.

11. Research on Dolphins

SOURCE: Science and Engineering (USSR), 19 May 1966, no. 20, pp. 4-6. (Summary)

Doctor of Biology Sergey Kleinenberg has been involved in Dolphin research for 12 years. Other scientists in the Sevastopol Institute of South Seas Biology are studying the hydrodynamics of dolphins and fish. Doctor of Biology Yuri Aleyev, who heads a department in the Institute, is studying the hydrodynamics of dolphins, sharks, and sturgeons relative to the design of underwater craft. A model of a sturgeon has been made which possesses slightly negative bouyancy properties and resembles an aircraft wing in shape. When pulled, the model lifts to the surface of the water demonstrating that the lifting capacity of fish is primarily a function of their shape. The antiturbulent quality of swimming dolphins and whales has been attributed to their exceptionally smooth and soft skin which damps swirls and eddies. When a soft synthetic material was applied to a torpedo, its speed increased by 50% with the same propulsion system.

12. Study of Dolphins in the USSR

SOURCE: Soviet Union (USSR), no. 197, 1966, pp. 40-41. (Summary)

The Ministry of the Fishing Economy of the USSR has banned the hunting of dolphins in the Black Sea and Sea of Azov. First Deputy Minister Valdimir Kamentsev explained that several teams of scientists are studying their biology. A large oceanarium is now being built near Sukhumi; it will have everything available for the observation of dolphins. This oceanarium will be much larger than the famous oceanaria in Florida and California, USA.

13. Studies of Whales

SOURCE: Candidate of Biological Sciences S. Klumov. Vokrug Sveta (USSR), no. 1, 1966, pp. 40-43. (Summary)

The author describes the characteristics of whales and theorizes that in addition to using their locators when searching for food, they may also be helped by their sense of smell. Regarding the orientation of whales, the author thinks that the solution of this problem is still distant. At present, in the biology of animals, there is no more complex and at the same time more important problem than the solution of their method of orientation.

ALPHABETICAL AUTHOR INDEX (by page number)